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SEDIMENT AND BIOLOGICAL ASSESSMENT OF THE NORTHERN WOOD PRESERVERS INC. SITE THUNDER BAY JULY 1995 and SEPTEMBER 1995

Final Report

AUGUST 1998

Ontario

Ministry of the Environment

ISBN 0-7778-7728-7

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OF THE NORTHERN WOOD PRESERVERS INC. SITE

THUNDER BAY

JULY 1995 and SEPTEMBER 1995

Final Report

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Environmental Monitoring and Reporting Branch
and
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Ontario Ministry of the Environment

Acknowledgments

The authors are indebted Dave Pugh and Sean Wong, Northern Ontario Region MOEE for their assistance with all field related activities for this project. Their extensive efforts in the field are greatly appreciated.

This study could not have been completed without the timely assistance of a great many individuals in the Laboratory Services Branch. In particular, the authors are deeply indebted to Dan Toner and staff of the Trace Organics Laboratory, and Eric Reiner and the staff of the Dioxin Laboratory for providing the extensive chemical analysis, under a very tight schedule, that are at the heart of this undertaking.

Table of Contents

Executive Summary v

1.0 Introduction 1

2.0 Methods 3
2.1 Phase I Studies 3

2.2 Phase II Studies 5

3.0 Results 5
3.1 Visual Observations 5

3.2 Chemical Analysis 6
3.2.1 Surficial Sediment - PAH 6
3.2.2 Core Samples - PAH 7
3.2.3 Sediment Bioassay Sediments - PAH 8
3.2.4 Surficial Sediments - PCB and Organochlorine Pesticides . . . 8
3.2.5 Surficial Sediments - Chlorophenols 9
3.2.6 Surficial Sediments - Dioxins and Furans 9
3.2.7 Surficial Sediment - Metals 9

3.3 Biological Analysis 10
3.3.1 Benthic Community Structure 10
3.3.2 Laboratory Sediment Bioassay 13

4.0 Discussion 18

5.0 Conclusions 23

6.0 Recommendations 24

7.0 References 26

Appendices

Appendix A Details of Sediment Bioassay Testing Methods

Appendix B Interim Sediment Quality Guidelines for Dioxins and Furans

List of Tables

Table 1. Thunder Bay - Northern Wood Preservers. Field Sampling Details and Sediment Description. July 17-20 1995.

Table 2. Description of Sediment Sampling Sites. Northern Wood Preservers, Thunder Bay. September 1995.

Table 3. PAH Concentrations in Surficial Sediment Samples. Phase I and Phase II.

Table 4. PAH Concentrations in Sediment Core Samples. Phase I.

Table 5. PAH Concentrations in Sediment Bioassay Samples. Phase I

Table 6. PCB and Organochlorine Pesticide Concentrations in Surficial Sediment Samples.

Table 7. Chlorophenol Concentrations in Surficial Sediment Samples. Phase I

Table 8. Chlorobenzene Concentrations in Surficial Sediment Samples. Phase I

Table 9 Dioxin and Furan Concentrations in Surficial Sediment. Phase I and Phase II

Table 10 Dioxin and Furan Concentrations in Surficial Sediment. Phase I and Phase II

Table 11 Metals Concentrations in Surficial Sediment. Phase I

Table 12 Distribution of Major Taxa. Phase I

Table 13 Distribution of Benthic Taxa. Phase I

Table 14 Mean Water Quality Characteristics in Sediment Bioassays.

Table 15 Summary of Biological Results for Sediment Bioassays. Phase I

Table 16 Summary of Biological Results for Sediment Bioassays. Phase II

Table 17 Test Precision and Discriminatory Power of Biological Endpoints. Phase I

Table 18 Test Precision and Discriminatory Power of Biological Endpoints. Phase II

Table 19 Association Between Sediment Toxicity and Sediment Total PAH Concentrations.

Table 20 PAH Concentrations in Fathead Minnow Tissues

Table 21 Mean Total PAH Concentrations in Fathead Minnows

List of Figures

Figure 1. Location of Control Stations and Sampling Transects, Northern Wood Preservers - Thunder Bay, July 1995

Figure 2. Location of Sediment Sampling Stations, July 1995. Surficial Grab Samples (Ponar).

Figure 3 Location of Sediment Core Sampling Stations, July 1995.

Figure 4. Location of Benthic Community Sampling Stations, July 1995.

Figure 5. Sediment Bioassay Sample Locations, July and September 1995.

Figure 6. Surficial Sediment Sampling Locations, September 1995.

Figure 7. Benthic Community Sampling Locations, September 1995.

Figure 8a. Sediment Total PAH - All Sites.

Figure 8b. Sediment Total PAH - All Sites. cont'd

Figure 9a. Sediment Total PAH in 100m Zone.

Figure 9b. Total PAH in Sediment Beyond 100m Zone.

Figure 10. Total PAH in Sediment Cores. 1988-1995.

Figure 11. Total PAH in Bioassay Sediments and Surficial Sediments.

Figure 12. Pentachlorophenol in Surficial Sediments.

Figure 13. Dioxins and Furans in Sediment. July & September 1995

Figure 14. Dioxin and Furan Total TEQ. Phase I and Phase II

Figure 15. Distribution of Major Taxonomic Groups, Phase I.

Figure 16. Distribution of Sediment Total PAH and Benthic Organisms, Phase I.

Figure 17. Chironomid Density and Total PAH, Phase I

Figure 18. Distribution of Benthic Taxa - Phase II

List of Figures cont'd.

Figure 19. Distribution of Major Taxonomic Groups, Phase I and II

Figure 20. Regression of Chironomid Density on Sediment Total PAH

Figure 21. Chironomid and Mayfly Mortality, Phase I and Phase II. Transect 5.5

Figure 22. Chironomid and Mayfly Mortality, Phase I and Phase II. Transect EF.

Figure 23. Mayfly and Chironomid Growth, Phase I and Phase II.

Figure 24. Regression of Mayfly Mortality on Sediment Total PAH

Figure 25. Regression of Chironomid Mortality on Sediment Total PAH

Figure 26. Sediment Total PAH and Fathead Minnow Mortality, Phase I.

Figure 27. Fathead Minnow Tissue Residues

Figure 28. Total PAH Concentrations in Sediment. July and September 1995

Figure 29. Delineation of Cleanup Zones Based on Total PAH Concentration in Surficial Sediment.

Figure 30. Concentrations of Selected Dioxins in Surficial Sediment. July and September 1995.

EXECUTIVE SUMMARY

The Northern Wood Preservers Inc. site in Thunder Bay Harbour has, under various owners produced creosoted wood products, such as railway ties and telephone poles, as well as treated lumber using pentachlorophenol, for over 50 years. Earlier studies have indicated that creosote residues have accumulated in sediments adjacent to the site, often to levels in excess of the Severe Effect Levels (SEL) of the Provincial Sediment Quality Guidelines. In addition, dioxins and furans (primarily heptachloro- and octachloro-dioxins and furans) have been identified in sediments adjacent to the site.

The Ontario Ministry of the Environment and Energy, and Environment Canada, undertook a joint investigation in 1995 to determine the extent and degree of sediment contamination using biological tests. This information would be used to determine which area needed to be remediated in accordance with the protocol developed by the Ministry (Jaagumagi and Persaud, 1996). The protocol requires biological effects testing using multiple endpoints when contaminant levels exceed provincial guidelines (Persaud *et al.* 1993).

In order to determine the extent of contamination for cleanup evaluation, dense sampling of the area based on a grid system was undertaken. Preliminary investigation showed that most of the creosote residues were within 100m of the site. In order to better delineate the gradation within the 100m zone, and develop a detailed sediment contaminant map of the area, sediment samples were collected at 25 m intervals along a total of 14 transect lines radiating out from the dock. Beyond the 100m zone, samples were collected 50m apart to a maximum distance of 500m. A total of 93 stations were sampled for sediment PAH and TOC.

Samples for PAH and TOC analysis were collected at 93 sites, while additional analyses for metals, PCBs, organochlorine pesticides, chlorophenols and chlorobenzenes were undertaken at 30 of the sites, as well as at the two control sites. Sampling for dioxins and furans was only undertaken at selected sites along 2 transect lines and the control site.

Biological sampling involved a field and lab component: benthic community structure and sediment bioassays. Benthic samples were collected along 4 transect lines as well as the two control sites.
Sediments (top 15-20 cm) for laboratory sediment bioassays were collected along the longest transect line and 1 control station. Bioassay tests were performed according to standard Ministry test procedures (Bedard et al., 1992).

Visual observations noted that the presence of creosote in sediment decreases with distance from the dock along all transect lines. In the area close to the dock (up to 100m), creosote was often encountered on the sediment surface, especially along the north facing transects. Along one transect, significant quantities of creosote were encountered within 50 m of the dock. In some of these locations (within 25m), liquid creosote formed over 50% of the sediment sample.

Sediment creosote content decreased with distance from the dock. Beyond 100 m, creosote was encountered only as small blobs or drops in the subsurface layers of the sediment. Sediment type along all transect lines was similar, and consisted of a thin layer of fine silt overlying a silt/clay mix.

Chemical Analysis. With the exception of PAH compounds and dioxins and furans, levels of all other organic compounds and metals were relatively low. The distribution of PAH compounds in sediment showed that along the north and east sides of the site, sediments are characterized by high concentrations of PAH (up to 16,327 ppm), but these decrease rapidly with distance from the dock. Sediment concentrations were typically lower along the southern section of the east side and very low along the south side.

Along the north side, all transects yielded sediment concentrations of total PAH above 300 ppm within 25m of the dock. However, by 50m levels at most sites were below 200 ppm and by 100 m concentrations were generally below 100 ppm total PAH. The exception was one transect where levels were above 300 ppm at 75m from the dock. By 175 m, most sediment concentrations were below 20 ppm total PAH, and continued to decline to near background levels with increasing distance.

Transects to the east generally showed lower concentrationsthe exception of T-EF. Sediments along this transect contained substantial amounts of creosote, which is reflected in the higher sediment total PAH concentrations at these sites (up to 1697 ppm). However, by 75m, concentrations were below 80 ppm and by 100m were near 30 ppm.

Dioxin and furan analysis was undertaken on a limited number of transects. The predominant dioxin compounds in sediment were the hepta- and octa- chlorodibenzo-p-dioxins and the hepta- and octa- chlorodibenzofurans. The lower chlorinated forms were present at very low concentrations or were not detectable. Typically, dioxin concentrations in sediment were higher than furan concentrations, with the octa- dioxin the predominant compound.

The distribution pattern of dioxins and furans around the site was similar to the PAH patterns. Concentrations were highest within 25m of the dock (up to 360,000 pg/g OCDD) and decreased rapidly with distance from the dock. At 100m, concentrations were less than 60,000 pg/g OCDD along the north and east transects.

Total TEQs for the dioxins and furans were also highest close to the dock and decreased rapidly with distance from the dock. Total TEQs were highest at sites within 25m (up to 1320 pg/g 2,3,7,8-T4CDD toxic equivalents), and suggest there is significant toxic and bioaccumulation potential associated with these sediments. However, since TEQs are based on mammalian toxicity, they may not be directly applicable to sediments. In addition, the availability of highly chlorinated compounds, such as OCDD are usually overestimated on the basis of partitioning coefficients, since molecular size has been suggested as limiting the passage of large molecules across cell membranes (Smith *et al.* 1988).

Benthic Community structure. Benthic communities at the sample sites consisted primarily of oligochaetes and chironomids. Oligochaete density and diversity did not show any relationship with sediment PAH cr PCDD/F levels (benthic samples were not collected in the creosote pool). Chironomid density was found to vary with sediment PAH concentrations in areas of high total PAH. At distances greater than 150m from the dock, neither density nor diversity showed a response to sediment PAH concentrations, which in this area were typically less than 30 ppm. The chironomid community showed reductions in density with higher sediment concentrations of total PAH. Along transects T-5.5 and T-7/9, stations close to the dock (25 m) had significantly fewer chironomids and fewer taxa. Since substrate type and depth were relatively uniform along these two transects, the most likely factor was the increase in sediment total PAH concentrations (chironomid density did show a weak negative correlation with sediment total PAH). A simple regression of density versus sediment total PAH suggested that a 50% reduction in chironomid density would correspond to approximately 150 ppm total PAH in sediment. Decreases in sediment total PAH concentrations were matched by increases in density of chironomids. The effects on chironomids suggest that below 30 ppm total PAH, there was no noticeable reduction in density.

Benthic community structure analysis indicated that beyond the 100m zone, the benthic community as a whole did not show any direct effects of high sediment concentrations of PAH.

Laboratory Sediment Bioassay. Sediment bioassay test results indicated that there was an increase in both mortality and growth impairment in the benthic species in those sediments close to the dock. Within the 100 m zone, the sediment bioassay results indicated that sediments within 75m of the dock along transect T-5.5 and within 25m of the dock along transect T-EF, were acutely toxic to both mayflies and chironomids. Sediments from the 100 m to 150 m distance along transect T-5.5 resulted in mayfly and midge growth impairment. At a distance of 175 m and beyond, both growth and mortality were similar to the control values and there was no detectable difference in effects between the test and control exposures. Sediment concentrations were at or below 30 ppm total PAH at these distances.

When the test results for the chironomid and mayfly toxicity tests were plotted against surficial sediment PAH concentrations (total PAH), both the mayfly and the chironomid mortality data indicated that there was an increase in mortality with increasing sediment total PAH concentrations. Greater than 50% mortality was found to occur in sediments from the 25m to the 75m distance. This corresponded to the zone where sediment total PAH concentrations were in excess of 150 ppm. Regression analysis between surficial sediment total PAH concentrations and bioassay test results found that the area of 50% mortality of chironomids coincided with the 150 ppm concentration of total PAH (lower 95% confidence limit) while the area of 50% mortality of mayflies coincided with approximately 130 ppm total PAH (lower 95% confidence limit).

Sediments beyond 75m showed little toxicity to mayflies and chironomids, but there was an inhibition of growth associated with these sediments. Only at the 175 m distance, where concentrations in sediment were near 30 ppm total PAH, did growth rates increase. Growth rates for both mayflies and chironomids stayed high from 175m to 500 m and equaled or exceeded

levels at the control.

Minnow results indicated that there was an increase in mortality at some stations within 100m of the dock. Along both transects T-5.5 and T-EF, mortality was highest at those locations where sediment total PAH concentrations were highest (i.e., 25m along T-EF and 75m along T-5.5).

The bioaccumulation data showed a gradient of PAH accumulation by fathead minnows such that locations close to the dock resulted in higher tissue residues. By 175m north from the dock, there were no detectable levels in minnow tissues. Analysis of the data showed a significant correlation between tissue residues and sediment total PAH.

Conclusions. The different levels of biological effects were used to define three zones of contamination.

The first, representing the most contaminated conditions, was the area of heavy, visible contamination of sediments by creosote (a creosote 'pool'). This area was located along transect line T-5 and was found to include the 50 m distance, but did not extend to the 75 m distance. Since transects on either side (T-4.5 and T-5.5) of T-5 did not yield similar quantities of creosote in the sediment samples, the "pool" appears to be confined to less than 50 m on either side. Cleanup of this area should proceed based on visual observation of creosote on the sediment surface. This area represents a continual source of creosote (and PAH contamination) to both the water column and adjacent sediments.

The second zone was defined on the basis of acute biological effects i.e., greater than and including 50% mortality in the test organisms, and coincides with the area of high PAH (>150 ppm) and dioxin/furan contamination (>200 ppt total TEQ). Sediments in this area should be adequately confined or removed since the toxic potential of these sediments is very high.

The third zone was defined on the basis of chronic biological effects and coincides with the sediment area exceeding 30 ppm of total PAH. This represents the area where contaminated sediments should be isolated in order to minimize contaminant effects on aquatic biota. Below this concentration, there was no measurable effect on benthic organisms.

Both contaminant concentrations and biological effects are low or not apparent in those areas below 30 ppm, and this area would be suitable for natural remediation since existing contaminant concentrations pose little threat to biota. Comparison with an earlier study by Beak (1988) indicates that surficial sediment concentrations of total PAH have decreased since 1987, likely through deposition of cleaner material on the surface. Active deposition of new material would serve to effectively isolate the relatively more contaminated sediments in the deeper layer and would permit longer term degradation of contaminants in this area with little concern regarding potential exposure to aquatic organisms.

1.0 Introduction

In July 1995, the Ministry of Environment and Energy's Northern Ontario Region, and Environment Canada, Remediation Technologies Program, requested the Environmental Monitoring and Reporting Branch to undertake a sediment and biological survey, in cooperation with the Region, of the Thunder Bay Harbour adjacent to the Northern Wood Preservers Inc. site.

The Northern Wood Preservers Inc. site has been identified as a major concern within the Thunder Bay Area of Concern. The plant has produced creosoted wood products, such as railway ties and telephone poles, as well as treated lumber using pentachlorophenol and chromated copper arsenate (CCA). Earlier studies have indicated that creosote residues have accumulated in sediments adjacent to the site, often to very high concentrations (Beak 1988; Hayton 1989). In addition, dioxins and furans (primarily heptachloro- and octachloro- dioxins and furans) have been identified in sediments adjacent to the site (Beak 1988). Dioxins and furans are common impurities in pentachlorophenol.

Beak (1988) found visible pools of creosote on bottom sediments adjacent to the site and recommended these be removed. In 1989 most of the visible pools were removed by suction dredging. However, a general cleanup of the area has not been undertaken.

The Beak (1988) study found that both polycyclic aromatic hydrocarbons (PAH), which are used as a surrogate for creosote analysis (creosote is composed mainly of PAH compounds), and dioxin and furan concentrations in sediment, decreased rapidly with distance from the site. As such, the most heavily contaminated zone appeared to be within 100 m of the dock to both the north and east.

The 1995 investigation was undertaken to better define the creosote and PCP-dioxin/furan contamination of the sediments, and to determine the concentrations at which biological effects were apparent. The intent was to use this information to determine the area to be remediated. Since a general cleanup had been planned for sediments located within 100 m of the dock, sampling was not undertaken within this zone during the initial or Phase I studies conducted in July 1995.

In order to determine the extent of contamination for cleanup evaluation, dense sampling of the area, based on a grid system, was considered necessary. Beak (1988) had identified an area from 100 m to approximately 200 m from the dock where concentrations decreased rapidly from over 500 ppm total PAH to approximately 24 ppm total PAH. In order to better delineate the gradation within this zone, sediment samples were collected at 25 m intervals. The intent of this component of the study was to develop a detailed sediment contaminant map of the area. This could then be used to aid any cleanup effort by defining more precisely the areas of contamination, identifying any "hotspots", and determining the contaminants of greatest concern within this area.

In most cases, surficial sediment samples were collected for analysis, since these represent current sediment conditions. Surficial samples were collected at all sites except those sampled by Beak (1988), where

core samples were taken for PAH analysis. Surficial samples were collected from the top 5 cm of each grab sample, since this represents the zone inhabited by most benthic organisms, and is also the zone most likely to be affected by resuspension from wave action or ship traffic.

Since the need for cleanup is driven by the severity of biological effects, biological sampling was also undertaken at a number of these transects. Biological sampling included benthic community structure, laboratory sediment bioassays, and where possible, benthic organism tissue residue analysis.

In September 1995, chemical and biological investigations of the zone from 0-100 m were undertaken in order to more closely define any hotspots in this area, and thus focus any subsequent remediation effort. This study formed Phase II of the sediment investigation.

The intent of the biological components of both the Phase I and Phase II studies was to establish a gradient of biological responses to different contaminant levels in sediment, and to relate this information to actual chemical concentrations. Through this means, chemical criteria could be established that could serve as a guide to sediment cleanup of those areas where biological effects were apparent. This would also serve to eliminate those areas where contaminant concentrations were above the Lowest Effect Level of the Provincial Sediment Quality Guidelines (PSQGs) (Persaud *et al.* 1993), but no biological effects were apparent. As part of the application of the guidelines, biological assessment is required where levels exceed the Lowest Effect Level or the Severe Effect Level.

The absence of biological effects is typically observed in those cases where contaminants are present in sediments at concentrations above guideline levels, but are unavailable to benthic organisms, usually as a result of the specific chemical nature of the contaminant. Many compounds that accumulate in sediments do so as a result of their highly stable configurations: these compounds are resistant to breakdown and do not dissociate in water (i.e. do not dissolve). However, due to their hydrophobic nature, these compounds will often partition to organic components of the sediment. In particular, organic carbon has been found to be the main controlling factor in partitioning of nonpolar organic compounds to sediment. It is through this type of partitioning that compounds such as PAHs and dioxins and furans, all of which are stable, nonionic (i.e. do not dissolve) compounds, accumulate in sediments. It is also due to this partitioning behaviour that typically, there is very little of the compound in the water phase (i.e. the water column). The availability of non-ionic compounds is often determined by their water solubility, which is expressed as a ratio of the amount of the compound that will dissolve in water relative to the amount that will dissolve in an organic solvent. This ratio is known as the partition coefficient, and is specific for each compound.

Availability of the compound to organisms is controlled by this partitioning. In order for organisms to accumulate compounds in their tissues, or to be affected by the toxic action of chemical compounds, the contaminant must be either available from the water column in its un-bound form, or the organism must be able to

extract the contaminant from the organic matrix and transport the molecule across cell walls to be incorporated into the organisms tissues. The latter typically only occurs when the substance is ingested and only where the compound shows a greater affinity for organism tissue (primarily lipids or fatty tissues) relative to the sediment organic matter. The greater the affinity of the compound to organic matter, the less likely it is to be extracted from the sediment. In addition, very large molecules, such as the octa-chlorinated dioxins, are generally limited by their size from passing through cell walls and are therefore not readily accumulated. Both toxicity and accumulation in tissues are controlled by the availability of the compound.

2.0 Methods

2.1 Phase I Studies

In order to determine the extent of PAH and dioxin/furan contamination of the sediments, a number of transect lines radiating out from the Northern Wood Preservers Inc. site were selected for sediment sampling and analysis. Figure 1 shows the location of the study site in relation to Thunder Bay harbour. A total of nine transect lines of various length were selected (Figure 2 shows the location of the transect lines). Lines running towards the east were shorter than those running to the north of the site, since these intersected the shipping channel and earlier studies indicated there was little fine sediment accumulation in these areas. The shipping channel is generally about 9 m in depth and, as such, is close to the maximum draft of most ships. As a result, sediments in this area are subject to significant resuspension and movement due to ship traffic. Transect lines to the north of the site were generally run to a maximum distance of 500m from the site. Distances are measured as actual distances from the dock. Along diagonal transect lines, such as T-7/9, T-CD and T-6/7, distances are reported as the distance along the diagonal. Transect lines were located on the basis of the Beak (1988) survey grid and have been labelled according to the Beak scheme. A total of 71 stations were sampled for sediment PAH and TOC as part of Phase I. All sampling was undertaken during July 17-20, 1995.

At 16 of the sites, core sampling was undertaken in order to duplicate the Beak (1988) sampling, primarily in an effort to determine if there had been any changes since 1988. Core sampling locations are shown in Figure 3. Cores consisted of a 1.5 inch lexan tube fitted either to a push rod/valve assembly (for shallow sites) or a Phleger corer. Where possible, cores were obtained to the same depth sampled by Beak, and followed the same sampling methodology. At each location, 3 replicate cores were taken and in only a few instances the core sample was greater than that sampled by Beak. Core sampling depths are presented in Table 1. The 3 replicates were combined to form one sample and this sample was used for PAH analysis and TOC (nutrient scan). The cores were not scraped on the outside as Beak had done, since the entire length of the core was used in most cases and therefore, smearing along the tube wall was not a concern.

At the 55 remaining stations, surficial sediment samples were collected (top 5 cm) with a standard 9" x 9" (23 cm x 23 cm) stainless steel Ponar grab sampler.

Three replicate samples were taken at each location and the top 5 cm from each replicate were combined and mixed to form a single sample. The samples were homogenized and from this homogenate, samples of sediment were collected into appropriate sample containers for analysis. Samples for PAH and TOC analysis were collected at all sites, while additional analyses for metals, PCBs, organochlorine pesticides, chlorophenols and chlorobenzenes was undertaken at 30 of the above sites (transect lines T-5.5, T-7/9, T-EF and T-CD, as well as the two control sites C1 and C2). Surficial sediment sampling locations are shown in Figure 2. Sampling for dioxins and furans was only undertaken at selected sites along transect lines T-5.5 and T-EF and the control site C-1. Standard Ministry analytical procedures were followed for all chemical analyses. These are described in detail in MOEE (1983).

Biological sampling involved three components: benthic community structure; sediment bioassays, and; in-situ benthic organism tissue residue analysis. Since benthic community densities were very low, artificial substrates, which consisted of wire mesh cages filled with local quarry rock, were used in an effort to obtain sufficient biomass of organisms for PAH analysis of tissues.

Benthic samples were collected with a Ponar sampler along transect lines T-5.5, T-7/9, T-EF and T-CD as well as the two control sites, C1 and C2. Samples were washed in the field to remove the fine debris using a U.S. # 30 mesh sieve. Three replicates were collected at each sampling station and the individual replicates were preserved separately in 10% formalin solution. Samples were subsequently sorted in the lab using dissecting microscopes, to separate the organisms from the debris. All three replicates were sorted individually, and from these results a mean value for each major taxonomic group was obtained. Subsequently, of the three replicates, the sample closest to the mean was selected for detailed identification of the organisms present. This involved identification to the generic level, with species identification where possible.

Sediments for laboratory sediment bioassays were collected with the Ponar sampler. At each location sampled (10 test stations + 1 control station) (sample locations are shown in Figure 5) approximately 10 L of sediment was collected; placed in polyethylene lined containers and shipped in refrigerated transport to the Etobicoke lab. Samples were collected only along the T-5.5 transect, the longest transect line in the study area. Details of the laboratory test procedure are provided in Appendix A.

Benthic organism tissue residue samples could not be collected due to insufficient numbers of organisms. Instead, artificial substrates, consisting of wire mesh cages (standard clam cages) filled with local rock were installed at seven sampling locations along transect T-5.5 at 50 m intervals beginning at 100 m. These were left in place for approximately 2 weeks and were retrieved and the organisms colonizing the rocks were collected. However, sufficient sample weight (5 gms) was not obtained at any of the sites. Reliance for tissue residue information was placed on analyses of sediment bioassay organisms (fathead minnows).

2.2 Phase II Studies

Additional chemical and biological investigations were undertaken during 25-26th of September, 1995, to further characterize the sediment and delineate the sediment hotspots within the zone 100 m from the dock.

During this phase, 38 stations were sampled along 10 transects (Figure 6). Surficial sediment samples were collected with a standard 9" x 9" (23 cm x 23 cm) stainless steel Ponar grab sampler. Three replicate samples were taken at each location and the top 5 cm from each replicate were combined and mixed to form a single sample. The samples were homogenized and from the homogenate samples of sediment were collected into appropriate sample containers for analysis. Samples for PAH and TOC analysis were collected at all sites. Sampling for dioxins and furans was undertaken at all sites, though samples were submitted only from selected sites along transect lines T-5.5 and T-EF and the control site C-1. Based on significant results from these samples, additional samples collected along transect lines T-7/9 and T-DE were submitted for analysis in order to better define the area of dioxin and furan contamination.

Biological sampling involved two components: benthic community structure, and sediment bioassays. The methods of sample collection and analysis are identical to those described above for the Phase I component. Location of benthic community analysis samples are shown in Figure 7. Sediment bioassay sample locations for both Phase I and Phase II studies are shown in Figure 5.

3.0 Results

3.1 Visual Observations

The results of visual observations of sediment type, and the types of samples collected at each of the sites, are presented in Table 1 for the Phase I sampling (July 1995), and in Table 2 for the Phase II sampling (September 1995).

In general, the presence of oil (creosote oil) in the sediment decreases with distance from the dock along all transect lines. In the area close to the dock (up to 100m), oil was often encountered on the sediment surface, especially along the north facing transects (Table 2). Along one transect, T-5, significant quantities of creosote were encountered within 50 m of the dock. In some of these locations (T-5 25 m), liquid creosote formed over 50% of the sediment sample (these samples were not submitted for analysis). Other north running transects (T-5.5, T-6 and T-4.5) showed only small amounts of surface oil, though some of these samples did have larger blobs of subsurface oil. The sediments in this area appeared to be lacking the surficial silt layer common in all other samples, and suggest disturbance of this area. This appears to coincide with the area cleaned up in 1989.

To the east of the dock, creosote was also encountered close to the dock along transect line T-EF. The sample from station T-EF-5 m (not submitted for analysis), for example, contained a large number of drops and small blobs of oil in and on the sediment surface. Little or no oil was encountered in other east facing transects, though significant quantities of wood waste were often encountered in this area. At the southeast corner, wood waste formed most

of the sediment.

Beyond the 100 m zone, the oil, when it was encountered, was primarily present in the subsurface layers of the sediment (Table 1). However, closer to the dock (100 m to 200 m) there was often surface oil as well, though this was usually only present as small droplets on the surface. In some locations, such as along transect line T-FG within 200 m, larger drops of oil were visible on the surface. Along transect lines T-FG and T-6.5, also within 200 m, there were periodic occurrences of large oil drops/blobs in the sediment, though these were typically below the 5 cm depth. At distances greater than 200m from the dock, there was usually very little visible oil in sediments along any of the transect lines.

Sediment type along transect lines to the north (T-5, T-5.5 and T-6.5) was generally the same throughout the length of the transect, and usually consisted of a thin layer of fine sediment overlying a silt/clay mix. In these locations clay was often encountered only near the bottom of the sample (10+ cm). In areas close to the dock along transect line T-5 and T-5.5, a thick bark layer was encountered below 5-7 cm, and this layer was often heavily contaminated with oil as well. Along transect T-5.5, the bark layer was found as far out as 200 m from the dock. This coincides with the area used for log booms in the past.

Sediment type along the transects to the east and southeast was more variable. The sediments close to the dock (within 200 m) were similar to those above, while beyond this distance, they typically consisted of a thin fine-grained layer of less than 5 mm, overlying clay. The density or firmness of the clay increased with distance out, such that at the 300 m distance (in the shipping channel), the clay layer was very hard and firm and often limited sampling. Along transect T-7/9 samples could not be obtained at the 430m (300m) station due to the hardness of the clay.

Sediments to the south, between the Northern Wood Preservers Inc. site and the CN ore dock, were typically wood waste within the first 50 m and beyond this zone consisted of fine-grained silts overlying a silt/clay mix, similar to those north of the site. No oil was visible in these sediments, though significant amounts of wood waste were encountered close to the dock.

3.2 Chemical Analysis

Results of chemical analyses are presented in Tables 3 through 11 for both Phase I and Phase II studies.

3.2.1 Surficial Sediment - PAH

Table 3 presents the results for PAH analysis on surficial sediments (top 5 cm) collected during Phase I and Phase II of the study.

The distribution of PAH compounds in sediment is shown graphically in Figures 8a and 8b for all sites sampled in both Phase I and Phase II. In general, the data indicates that along the north and east sides of the site, sediments are characterized by high concentrations of PAH, but these decrease rapidly with distance from the dock. The data also show that sediment concentrations are typically lower along the southern section of the east side (transect lines T-DE,

T-D, T-CD and T-6/7) and most of the contamination is confined to the north and northeast sides.

Within 100m of the dock (Figure 9a), the highest concentrations were along the north face. In particular, concentrations were very high along transect T-5, where a pool of creosote was found during Phase II. Samples were not analyzed from station T-5-25m since the sediment sample in this area was comprised mainly of creosote. Sediments at station T-5-50m were also heavily contaminated with creosote and analysis yielded a concentration of 16,327 ppm of PAH, the highest concentration of any of the sites. However, this area appears to be confined to within 75m of the dock, since sediment PAH concentrations at 75m were comparable to other north transects. Similarly, sediment concentrations along transects on either side of T-5 (T-4.5 and T-5.5) while high, were substantially lower than T-5 and suggest the pool is confined to less than 50m on either side of transect T-5 and less than 75m north from the dock.

Along the north side, all transects yielded sediment concentrations of total PAH above 200 ppm within 25m of the dock. However, by 50m levels at most sites were below 200 ppm and by 100 m concentrations were generally below 100 ppm total PAH (Figure 9b). The exception was transect T-5.5, where levels were above 300 ppm at 75m from the dock. By 175 m, most sediment concentrations were below 20 ppm total PAH, and continued to decline to near background levels with increasing distance.

Sediment concentrations along transect T-7/9, which ran northeast from the corner of the dock (Figure 2), were higher close to the dock (< 100 m), but levels were similar or lower than along other north transects.

Transects to the east (Figure 2) generally showed lower concentrations in sediments, with the exception of T-EF. These sediments contained substantial amounts of creosote, which is reflected in the higher sediment PAH concentrations at these sites. Concentrations of total PAH within 50 m of the dock were the highest of any sites with the exclusion of transect T-5 (creosote pool). There was a noticeable trend along the east side, with concentrations decreasing from north to south. The southeast corner of the dock (Transect 6/7) yielded the lowest concentrations.

The distribution of PAH in sediment around the dock, within the 100m zone indicates that most of the north face and part of the east face (the northern 100m) are significantly contaminated with PAHs out to distance of 75 to 100m. The biological significance of these high concentrations is discussed in Section 4.

Contamination remains high as far out as 150 m but then decreases rapidly such that by 175m, concentrations along most transects were below 20 ppm.

3.2.2 Core Samples - PAH

Results of PAH analysis for the sediment cores (collected only along three transects during the Phase I investigation) are presented in Table 4. The results indicate that concentrations in sediment cores along the north transect (T-5) were generally similar to concentrations in

surficial samples (Tables 3 and 4). Concentrations along the other 2 transects were generally much higher close to the dock (100 - 150 m) but by 200 m out, levels had decreased to levels similar to those found in surface sediments. Since sediment cores integrate concentrations over a greater depth of sediment than the surface samples, the higher concentrations close to the dock suggest that there is a higher level of subsurface oil in these sediments. The levels of creosote in the sediment appear to be more uniform further out, since concentrations in core and surficial samples were very similar. By 200m from the dock, concentrations in both surficial and core samples were at or below 15 ppm total PAH.

Comparison of current core data with 1988 data (Beak 1988) suggests there has been a decrease in PAH concentrations, with the most significant reduction occurring in areas close to the dock (Figure 10) along the north and north-east transects. PAH concentrations were similar along the east transect T-EF in both 1988 and 1995.

3.2.3 Sediment Bioassay Sediments - PAH

As part of the sediment bioassay procedure, sediment samples are taken from the sieved and homogenized test sediments for chemical analysis. Samples were submitted for analysis from all of the test sediments except the control sediments. Unlike surficial sediment samples, the entire sediment sample collected in the Ponar sampler (up to 20 to 25 cm deep) is used for sediment bioassay testing. Testing of this material then, is similar to testing a large number of core samples. Concentrations in these samples tend to be higher in general, since only the fine sediment fraction is used. Sieving of the sediments tends to concentrate on the sediment fraction to which most organic contaminants bind.

The results are presented in Table 5. Total PAH concentrations in samples within 150m of the dock indicate higher levels in sediment than either the surficial samples or the cores. Concentrations ranged up to 259 ppm, though this is still considerably lower than the level encountered in 1988 in this area (Figure 10). At the 175m distance, sediment concentrations in the bioassay sediments had decreased to approximately 30 ppm. By 200 meters out, concentrations in the sediment bioassay sediments were very similar to concentrations in surficial sediments (Figure 11). The similarity of surface and bioassay sediments beginning at 175m from the dock suggests there is less subsurface oil in these sediments.

3.2.4 Surficial Sediments - PCB and Organochlorine Pesticides

The results of PCB and organochlorine pesticide analysis from the Phase I study are presented in Table 6. The locations were the same as those for surficial sediment PAH analysis. Except for b-BHC, all compounds were below detection limits. While higher concentrations of b-BHC were found at a number of stations, these did not differ significantly from concentrations at the Control stations. Sediment b-BHC levels appear to be a general concern within the harbour and cannot be directly linked to any specific source.

Since most compounds were below detection limits, these analyses were not

repeated in Phase II of the study.

3.2.5 Surficial Sediments - Chlorophenols

Surficial sediments collected for PAH analysis were also analyzed for chlorophenols. The results are presented in Table 7.

Only pentachlorophenol was detected in sediments; levels of tri- and tetra-chlorophenols were all below detection limits. Concentrations of PCP were highest close to the dock and decreased to below detection limits with increasing distance (Figure 12). PCP was detected in sediments along the north and east sides of the dock, with the highest concentrations (80 ppb) along both the T-5.5 and T-EF transects out to a distance of 150 m.

3.2.6 Surficial Sediments - Dioxins and Furans

Dioxin and furan analysis was undertaken during both Phase I and Phase II studies since the higher chlorinated compounds (octa dioxins and furans) are common impurities in pentachlorophenol. Sediments from two transects, T-5.5 and T-EF, were submitted for analysis during Phase I. In Phase II the above transects were sampled within the 100m zone. In addition, based on the results of those analyses, two additional transects, T-7/9 and T-DE were also submitted in order to better define the area of dioxin/furan contamination. The results of both Phase I and Phase II studies are presented in Tables 9 and 10.

The predominant dioxin compounds in sediment were the hepta- and octa-chlorodibenzo-p-dioxins and the hepta- and octa- chlorodibenzofurans. The lower chlorinated forms were present at very low concentrations or were not detectable. Typically, dioxin concentrations in sediment were higher than furan concentrations, with the octa- dioxin the predominant compound.

The distribution pattern around the site was similar to the PAH and chlorophenols patterns. Concentrations were highest along the north side (transect T-5.5) and the northern part of the east side (transect T-EF) (Figure 13), though concentrations on the east side close to the dock (T-EF-25m) were higher than along the north side. However, concentrations decreased more rapidly along the east side, likely due to a less favourable depositional environment as a result of the resuspension of sediment in the shipping channel.

Total TEQs for the dioxins and furans were also highest close to the dock and again decreased rapidly with distance from the dock. Total TEQs were highest at station T-EF-25m, and suggests there is significant toxic potential associated with these sediments.

3.2.7 Surficial Sediment - Metals

Analysis for metals was undertaken only at those sites where PCB/OC analysis was conducted. Results of metals analyses are presented in Table 11.

While concentrations of a number of metals exceeded the LEL, concentrations throughout the study area were similar and suggest that levels represent general ambient conditions in the harbour.

Due to the consistent distribution pattern of metals throughout the study area, the Northern Wood Preservers Inc. operation does not appear to be a significant source for metals to adjacent sediments. As a result, additional analyses for metals were not undertaken in Phase II.

3.3 Biological Analysis

3.3.1 Benthic Community Structure

Benthic community structure analysis was used as one of the tests to determine the impact of contaminants in sediments on biota.

Benthic communities (i.e., those organisms that live in, and often ingest, sediments) have long been used as a measure of the effects of contaminants. The method makes use of the different responses to contaminants among different groups of organisms. The analysis considers those organisms that are present, as well as considering those that would be expected to be present, but for some reason are not. The method is based upon the classical ecological definition of a natural, undisturbed community as one that consists of a few species which are commonly distributed and present in greater densities, and a larger number that are sparsely distributed and relatively rare. In a natural state, such a community exists as a balance between these two groups. Under environmental stresses, the natural balancing mechanisms (e.g., availability of food, predation, competition for resources) are disrupted and an unnatural stress-defined community develops. These are usually characterized by the absence of the more intolerant or sensitive groups and the overwhelming presence of a few groups that are tolerant of the new conditions. Under conditions of chemical contamination, for example, both diversity (the range of different types of organisms present) and the density (the actual numbers) are reduced, as only those tolerant of the contaminant(s) are able to survive.

Where the toxic effects of contaminants are high (i.e., highly toxic compounds, high concentrations or high bioavailability of the contaminant) the effect on the benthic community is usually severe: elimination of most of the benthic taxa, and the presence, in very low numbers, of those few that are tolerant. Conversely, where contaminant concentrations are low, or there is low bioavailability of the substance, the effect on the benthic community may be minor, such as a slight reduction in overall density. Where low concentrations of contaminants are present, those organisms present are often indicative of long-term chronic effects on organisms, since the community that exists is the result of the effects of the contaminant(s) acting over a number of generations.

In interpreting benthic community information a number of natural factors need to be considered, since the nature of the community depends not only on the presence of contaminants, but also natural factors such as substrate type and water temperature. Most benthic organisms have specific habitat requirements. Some, for example, prefer soft fine-grained sediments, while other species may prefer hard substrates. These preferences are usually based upon the feeding requirements of the organisms. Those that feed by ingesting sediments (i.e., that feed upon the organic fraction) will usually require fine-grained

material with some organic matter. For example, both chironomids (midge larvae) and oligochaetes (aquatic relatives of earthworms) ingest sediments to extract organic matter and are often the most common components of benthic communities in quiescent water such as lakes and ponds.

Differences are also apparent in temperature requirements, and generally, cold waters support fewer different types of organisms than warm waters.

Therefore, the analysis must also consider habitat characteristics in conjunction with presence-absence of taxa.

Samples for benthic community structure analysis were collected along transects T-5.5, T-7/9, T-EF and T-CD during Phase I, as well as the control stations C1 and C2 (Figure 4). These locations coincide with the sites where complete chemical analysis of sediments was undertaken.

The results of the benthic community analysis are presented in Table 12 and are listed on the basis of major taxa found at each location. These results are the mean values for the three replicate samples collected at each station. The specific species composition is presented in Table 13.

Figure 15 shows the density of the major benthic taxonomic groups. The distribution of benthic taxa indicates that beyond the 100m zone, there is little correlation between benthic communities and the presence of contaminants. Only along transect T-5.5 were benthic communities close to the dock (in areas of higher sediment PAH contamination - i.e. within 100-150m) reduced in numbers as compared to those stations further out. Along this transect the highest density was found at station T-5.5-175m, though diversity was slightly lower than at stations closer to the dock. However, the differences in density were not statistically significant. Density was similar to the control station C1, though the composition of the benthic communities was rather different. The higher number of chironomids at C1 and the reduced numbers of crustaceans (mainly amphipods) and molluscs at the control is likely a reflection of the deeper water depth at this location. Both amphipods and molluscs (mainly sphaeriids- "fingernail clams") prefer shallower water in areas of fine-grained organic substrates and thus would be less likely to inhabit the deeper water at C1.

Along the other transects, stations within the 100 - 150m zone exhibited the highest densities of organisms (Figure 15). While diversity of organisms did not change appreciably along the north (T-5.5) and north-east (T-7/9) transects, there was a notable reduction in both density and diversity of organisms along the east (T-EF) and south-east (T-CD) transects. Both of these transects crossed into the shipping channel at approximately 200m from the dock, which was characterized by hard clay substrates overlain with only a thin layer of fine-grained sediments (see Table 1). Such areas would be expected to be less well inhabited due to reduced organic matter (i.e. reduced availability of food) and unsuitable substrate (clay would limit the burrowing forms such as chironomids and oligochaetes, which generally prefer softer fine-grained sediments for this reason).

While there was no statistical correlation between sediment PAH

concentrations and benthic organisms, in part this may be due to the unsuitable substrates along the transects to the east and southeast. Individual taxa did not show any correlation with sediment PAH with the exception of chironomids. When transects T-5.5 and T-7/9 only are considered, there is a weak negative correlation between sediment total PAH concentrations and density of chironomids ($r=-.6794$ $p<0.05$) and suggests that the lower density of these organisms close to the dock may be related to higher levels of PAH in the sediments. Figure 17 shows the distribution of chironomids in relation to sediment total PAH concentrations. It should be noted that the lower density of chironomids at distances 290m and 360m along transect T-7/9 is more likely a result of the hard clay substrate, which would limit this area as suitable substrate, rather than a response to the higher PAH concentrations. Species composition (Table 13) shows that those species commonly associated with fine-grained organic-rich substrates, such as *Chironomus, Cryptochironomus, Dicrotendipes, Cladotanytarsus* and *Micropsectra* were absent at these stations.

As indicated above, there was no relationship between oligochaete density and PAH concentrations beyond the 100m zone, except for a weak relationship along transect line T-5.5. As noted for the chironomids, density of oligochaetes was lowest close to the dock and increased with distance. However, even close to the dock, the numbers of organisms was similar to those at the control stations. Along transects T-7/9, T-EF and T-CD, both density and sediment total PAH concentrations decreased with increasing distance from the dock. The decrease in oligochaete density is most likely attributable to the predominantly clay substrate in these areas.

Molluscs and amphipods, both of which inhabit the sediment surface, did not show any relationship with sediment PAH levels. Both of these groups showed highest densities close to the dock, with decreasing density further away. This suggests habitat (water depth and substrate type), rather than contaminant levels, may be the primary factor affecting their distribution. Amphipods in particular were only found along transect T-5.5, which was also the shallowest area sampled.

The reduction in density of chironomids and oligochaetes within the 100m to 150m zone coincided with the highest levels of sediment contamination by PAHs. As concentrations decreased, densities of both these organisms increased. At concentrations of 25-30 ppm, density of chironomids was similar to the control stations.

Results of the Phase II studies are also presented in Table 13 and shown in Figure 18. Stations close to the dock did not show any clear response to sediment contaminant concentrations, at least as far as overall numbers of individuals or taxa. When the Phase I and Phase II data are combined, as shown in Figure 19, there was a significant increase in density of organisms apparent along transect T-5.5 at the stations within 75 m of the dock. However, most of the increased density was due to a significant increase in the number of molluscs (fingernail clams) and isopods. Both of these groups inhabit the sediment surface, and therefore are less likely to come into direct contact with contaminants in sediments.

In contrast, some of the groups inhabiting the sediment did show a reduction in both density and diversity at those locations close to the dock. In particular, the density of chironomids at the stations within 75 m of the dock was generally lower than those stations further out. Diversity of benthic taxa was also reduced, particularly at the 25 m distance along both transects T-5.5 and T-7/9. Much of the reduction was in the diversity of chironomids, which were reduced to only one or two taxa, and suggest that factors other than substrate type may be responsible since there was little difference in sediment type among these stations and other stations further out along these transect lines. Both of these areas corresponded to higher sediment total PAH concentrations.

A similar decrease was not observed among taxa along transect line T-EF, though the 25 m distance was not sampled along this transect.

Simple correlation (Spearman Rank) between chironomid density and sediment total PAH (transects T-5.5 and T-7/9 only) showed a weak negative correlation ($r=-.6794$; $p<0.05$) and suggests that the reduction in chironomid density may be due to PAH levels in the sediment. Transect to the east were not included in the analysis, since habitat characteristics were found to be too variable along these transects.

Simple regression of density of chironomids with sediment total PAH concentrations (Figure 20) suggests that a 50% reduction in chironomid density could be expected at a sediment total PAH concentration of approximately 150 ppm.

3.3.2 Laboratory Sediment Bioassay

Whole-sediment toxicity tests were conducted using the mayfly nymph, *Hexagenia limbata* (21-day exposure, survival and growth), the midge larvae, *Chironomus tentans* (10-day exposure, survival and growth) and the juvenile fathead minnow, *Pimephales promelas* (21-day exposure, survival and chemical bioaccumulation). The battery of sediment toxicity tests used provide a number of endpoints using organisms representing different trophic levels in order to measure differences in sediment quality. The laboratory toxicity tests provide a cost-effective technique for determining if sediment-associated contaminants are harmful to benthic organisms or are being released into the water-column. In conjunction with appropriate control sediments, spatial differences in sediment quality, and the relative availability of contaminants and their potential impacts can be ascertained.

Water Quality Test Parameters

Conductivity, pH, total ammonia, un-ionized ammonia and dissolved oxygen parameters were measured in the overlying water periodically during the course of the bioassay testing. Data for each test species are recorded in Table 14, for both Phase I and Phase II. Values are reported as mean $\pm$ standard deviation. Generally, water quality measurements were similar among the test sites. pH ranged from 7.0 to 8.2 and conductivity from 279 to 447 umho/cm. In the minnow bioassays, average pH values were slightly lower and conductivity values were somewhat higher, as compared to the tests using the benthic species. Dissolved oxygen within the test jars remained above

acceptable levels (>4 mg/L) throughout the test (OMOE, 1984). Test temperature averaged 20°C to 21°C for each bioassay.

Total ammonia readings were elevated for the majority of the test sediments and the reference sediment, in the minnow sediment bioassay. After conversion to the un-ionized form of ammonia, based on test temperature and pH, levels in the overlying water in each of the jars holding reference and test sediments, exceeded the water quality objective of 0.02 mg/L (OMOE, 1984). Average un-ionized ammonia measurements for the minnow Phase I and Phase II toxicity tests were 0.06 and 0.23 mg/L, respectively. The lowest readings were recorded for the negative control sediment.

Mayfly (*Hexagenia limbata*) 21-day Lethality and Growth Results.

The biological data for the two endpoints, mortality and growth, for the Phase I study are summarized in Table 15. Mayfly percent mortality remained below 10% for all control and test sediments with no statistical differences reported between each of the test sediments relative to either control sediment (Dunnett's *t*-test, $p < 0.05$).

Significant differences in the sublethal growth endpoint were measured among sites ($p < 0.0001$). The data, represented by individual fresh weights, showed a 50% growth reduction at Stations T-5.5-100 m, -125 m and -150 m, relative to the other test sites (Range: 11.4 to 17.8 mg). Animals exposed to sediments collected from Station T-5.5-175 m to T-5.5-500 m attained similar or higher weights as the reference control mayflies (10.2 mg), and represent a doubling in size from the initial starting weight of 4.7 mg. The lower mayfly growth obtained for the control sediment (average weight 7.8 mg) is probably due to the quality and quantity of the nutritional value associated with the sediment due to the prolonged storage of this sediment, relative to the fresh detrital material found in the reference and test sediments.

The biological results for the Phase II toxicity tests are reported in Table 16. Mayfly mortality was statistically higher at certain test sites relative to both negative and reference control sediments ($p < 0.0073$). Sediments collected from Station T-5.5-75 m and T-EF-25 m were found to be acutely toxic (100% mortality) to *Hexagenia*. Observations made within the first 24 hours on the test chambers containing Station T-5.5-75 m and T-EF-25 m sediment, indicated that all of the animals were on the sediment surface. The mayflies showed minimal activity such as swimming or attempts at burrowing, and exhibited a strong avoidance behaviour of the sediment. Death (100% mortality) was achieved within 6 days for Station T-EF-25 m sediment and >75% mortality by Day 8 for Station T-5.5-75 m sediment. Mayfly avoidance behaviour was also noted at Station T-5.5-25 m during the first four days and resulted in significant lethality (50% mortality) by Day 21. Biomass of the surviving nymphs for the remaining test sediments were similar among test sites and were significantly lower than the reference control animals.

Chironomid (*Chironomus tentans*) 10-day Lethality and Growth Results

Results for chironomid growth and

lethality for the Phase I toxicity tests are reported in Table 15. Percent mortality for the midge ranged from 0% to 17% and is within the acceptable control mortality value of 25%. There were no significant differences in midge mortality among sites.

Similar to the mayfly assay (July survey), a 50% growth reduction in the midge was reported at Stations T-5.5-100 m, -125 m and -150 m and is statistically lower than those attained for both control sediments and the remaining test sediments (Range: 9.7 to 12.5 mg) ($p < 0.0001$).

Data obtained from the toxicity test conducted for the Phase II survey are reported in Table 16. Significantly higher lethality was noted for three of the test sediments ($p < 0.0001$). After 10 days, sediment from Station T-EF-25 m resulted in 100% mortality, 58% mortality for Station T-5.5-25 m and 54% mortality for Station T-5.5-75 m. Percent mortality at these sites was statistically different from the negative control, reference control and the other test sediments. Control mortality ranged from 15% to 16% and was below the acceptable control mortality of 25%. Sediments which exhibited poor organism survival also showed lower body weights ($p < 0.0001$).

Fathead Minnow (*Pimephales promelas*) 21-day Lethality Results

Juvenile fathead minnow percent mortality data are reported in Table 15 for the Phase I toxicity tests. Percent mortality for Station T-5.5-150 m was statistically higher than the negative control, reference control, Station T-5.5-125 m and T-5.5-400 m sediments ($p < 0.001$). In addition, using Dunnett's *t*-test for comparing percent mortality between each test sediment and both of the control sediments, it was determined that test sediment from Station T-5.5-150 m (66% mortality) and T-5.5-175 m (56% mortality) was significantly different than both control minnow survival values. Daily records indicate minnow mortalities began to occur on Day 14 and continued until Day 21. Sediment avoidance behaviour was noted within the first 48 hours for Station T-5.5-100 m and T-5.5-125 m exposures.

Table 16 summarizes the fathead minnow toxicity test results for Phase II. Percent mortality among treatments were significantly different ($p < 0.0001$). The most toxic sediments were Station T-5.5-75 m (73% mortality) and Station T-EF-25 m (93% mortality). Both test sediments resulted in lethality greater than the negative and reference control exposures (Dunnett's *t*-test). Fish exposed to Station T-5.5-75 m and T-EF-25 m sediments exhibited a loss of equilibrium with a tendency to swim in a vertical manner, within 24 hours after their introduction into the test chambers. Avoidance of the sediment, reduced swimming activity and lack of sediment disturbance continued for at least four days. Death initiated on Day 16 and the rate of death increased until the end of the test. The remaining test sediments had statistically similar percent mortality values (Range: 0% to 16% mortality).

Reference Toxicity Tests

For Phase I, the 48-hour copper LC50 (95% C.I.) for the water-only reference toxicant exposure for *H. limbata* was 1.61 (0.96 - 3.86) mg/L. This value

was within the acceptable 48-h LC50 (± 2 s.d.) range of 1.38 (1.43) mg/L, according to a previous series of reference toxicant tests. Similarly, for *C. tentans*, the LC50 was 1.84 (1.33 -2.91) mg/L, as compared to an expected 48-h LC50 (± 2 s.d.) of 1.48 (0.98) mg/L.

For Phase II, the 48-hour copper LC50 (95% C.I.) for the water-only reference toxicant exposure for *H. limbata* was 1.81 (1.01 - 5.26) mg/L. This value was within the acceptable 48-h LC50 (± 2 s.d.) range of 1.41 (1.33) mg/L, according to a previous series of reference toxicant tests. Similarly, for *C. tentans*, the LC50 was 0.84 (0.69 - 1.01) mg/L, as compared to an expected 48-h LC50 (± 2 s.d.) of 1.53 (0.93) mg/L.

Comparison Among Test Organisms and Endpoints

In the Phase I toxicity tests, the growth endpoint for both benthic species had acceptable test precision values (14 - 15 % C.V.) due to a range of growth effects (Table 17). Lethality showed a limited range of response resulting in higher % C.V. values. The mayfly assay had slightly higher discriminatory power relative to the midge or minnow bioassays.

For the Phase II toxicity tests, both the lethal and sublethal endpoints measured for both of the benthic species had excellent test accuracy (11 - 27% C.V.) (Table 18), with the mayfly assay exhibiting the best ability to measure differences in sediment quality based on organism survival (D.P. = 19.6). The midge assay indicated a similar trend in sediment quality using either survival or growth as an endpoint (D.P. = 9.2 and 9.5).

The minnow assay for the Phase II study had a better tendency to discriminate between lethal and non-lethal sediments, as compared to the Phase I results. This was in part, due to the less within treatment variability (28 % C.V.).

Based on the available data for the Northern Wood Preservers Inc. test sediments, there appears to be an association between the relative distribution of PAH compounds measured in the bioassay test sediments and the degree of biological effects measured in the laboratory (Table 19). The incidence of significant organism mortality was higher for those sediments collected during the second survey. Acute toxicity to the mayfly and midge was measured along transects T-5.5 and T-EF at distances of 25 metres and 75 metres respectively. These sediments had an oily sheen and emanated a strong to moderate odour of a creosote-type compound.

It was also apparent in the first survey that those sediments collected between 100 metres and 150 metres along transect T-5.5 elicited significantly poorer midge and mayfly growth, relative to those sediments collected at a greater distance. Differences appear to be attributed to sediment total PAH concentrations. The LC_{50} for the mayfly and midge toxicity tests appears to fall within a sediment total PAH concentration of 150 ppm (based on field surficial sediment data). This value compares favourably with that reported for the amphipod, *Diporeia sp.*, in a dose-response laboratory experiment using PAH-spiked sediment in a 26 day test. Landrum *et al.*, (1991), found a lethal exposure concentration of 100 ppm dry weight, for

total PAHs and the mode of toxic response was attributed to nonpolar chemical narcosis. The lack of minnow toxicity at Stations T-5.5-100 m and T-5.5-125 m appear to be correlated with fish avoidance to the contaminated sediment. Overall, effects on fish mortality were more variable at each site for the Phase I toxicity tests. Sediments collected at Station T-5.5-150 m and Station T-5.5-175 m, resulted in statistically higher fish mortality relative to the negative and reference control sediments.

Chemical Bioaccumulation in *Pimephales promelas*

The examination of organic chemical availability to aquatic organisms is valuable for assessing the potential for chemical transfer through the food web. The primary objective of this bioassay is to make general observations on whole organism tissue concentrations as they relate to total PAH chemical concentrations in the sediment and differences in chemical uptake among sites. Surviving fathead minnows were submitted for PAH analysis for 16 individual compounds and results are based on whole-body tissue concentrations (ng/g dry weight). Analysis of tissue residues from Phase II is currently in progress and results will be provided as an addendum to the final report.

The sources for PAH accumulation to forage fish include direct contact with the sediment and uptake from the overlying water. Factors that control PAH accumulation by forage fish include those that affect chemical adsorption and desorption such as organic content, particle size, chemical partitioning coefficients (e.g. log Kow). Biotic factors affecting uptake include metabolism and lipid content.

Table 21 summarizes the total PAH concentrations (dry weight) measured in juvenile fathead minnows and sediment bioassay samples for Phase I. Concentrations in fathead minnows were based on unequal sample sizes due to the loss of animals and insufficient biomass across all treatments. A gradient in PAH accumulation was evident. Minnow tissue PAH concentrations were significantly correlated to the total PAH sediment concentrations ($r=0.76$; $p<0.01$). The highest total PAH concentrations in minnow tissues was recorded for station T-5.5 - 150 m (8844 ng/g), followed by station T-5.5 - 125 m (3953 ng/g). Trace amounts were also detected in minnows exposed to station T-5.5-100m sediment. Non-detectable amounts were reported for the remaining control and test animals sediments (2680 ng/g) and were representative of pre-exposure conditions.

The significantly lower chemical accumulation by minnows at station T-5.5-100 m, despite the relatively high sediment total PAH concentration of 213 ppm, could be due to the stronger avoidance behaviour by the minnows and reduced feeding and movement which could result in lower chemical uptake. A similar effect, but to a lesser degree, occurred at station T-5.5-125 m. At those locations where tissue concentrations above trace amounts were observed, PAH compounds, fluoranthene, benzo(b)fluoranthene and pyrene, contributed to the overall residue concentrations to the greatest extent (Table 20). Chemical uptake appears to be related to the relative distribution of compounds found in the sediment at these locations

(Table 5).

The relatively low accumulation of PAHs in fathead minnows is a result of the ability of many vertebrates, including fish, to metabolize PAHs and their rapid elimination through the bile, feces and urine (Kennedy and Law, 1990). The enzyme system that is principally involved in the biotransformation of PAHs is the cytochrome P-450 mixed function oxidase (MFO) system. In addition, the relatively short exposure duration of 21 days would likely underestimate steady-state tissue concentrations. These factors would maintain concentrations in the fish at levels lower than those found in the sediment. However, tissue concentrations remain a valuable measure of PAH availability.

4.0 Discussion

The visual survey of the area around the Northern Wood Preservers Inc. site in Thunder Bay confirmed that there is visible contamination of sediments with creosote oil. The heaviest contamination lies within 100 m of the dock on the north face and part of the east face, while significantly less oil was visible along the southeast and south faces of the dock. In most cases, the oil was present as drops or small (< 1 cm diameter) blobs in and on the sediment surface. However, along the north face at transect line T-5, there was heavy surface contamination. Within 50m of the dock along this transect, creosote formed a significant portion of the sediment samples retrieved by the Ponar grab, and indicates the presence of a pool of creosote on the sediment surface. No evidence of surface pools was obtained along any of the other transects.

Stations close to the dock (25m) along transect line T-EF, yielded large blobs of oil in and on the sediment surface and next to the samples from transect T-5 were the most visibly contaminated with creosote. However, by 50 m there was little evidence of oil in the sediments and the contamination here appears to be confined to an area close to the dock.

To the southeast and south, there was little contamination of sediments with oil. However, in this area, sediment consisted of primarily fine wood waste with little fine-grained material.

Beyond the 100m zone the occurrence of oil in sediment decreased substantially. Large pockets of oil, such as were noted close to the dock, were not encountered in this area. Samples collected along transect lines T-5.5 and T-7/9 on the north face had some surface oil on the sediment, but in most cases this was usually present merely as small droplets. Oil was usually not visible on the sediment surface in samples from 200m or more from the dock, though subsurface oil droplets were found in some cases as far out as 300m. Samples collected along the east face showed surface contamination, again by only small droplets of oil, as far out as 150m. Subsurface oil was present as small drops up to 200m from the dock.

The sediment analysis for PAH indicates a similarly rapid attenuation of sediment concentrations. In the area close to the dock (within 100m) concentrations ranged up to 16,327 ppm, though typically concentrations were in the range of 100 ppm to 400 ppm (Figure 9a). Beyond the 100m

zone, the highest levels ranged from 50 to 60 ppm in surficial sediments. However, both core samples and bioassay sediments, which sample a much deeper sediment profile, yielded concentrations of total PAH that were approximately 4 times higher than surficial sediment concentrations. These results indicate the presence of subsurface oil (as measured by PAH concentrations) at higher levels than in the surface layer. A comparison of concentrations in core samples collected in 1988 vs. those collected in July 1995 indicate there has been a considerable decrease in the level of PAH along transects to the north and northeast. There was a less significant change in levels to the east, though levels were still higher in 1988 than in 1995.

A comparison with sediment bioassay samples, which typically sample to 20 cm depth, indicates a similar decrease in sediment concentrations. While sediment concentrations were very different between the cores and surficial samples close to the dock, by 200m concentrations in both samples were very similar. This, in turn, suggests that the level of both surface and subsurface oil has decreased by this distance.

The rapid decrease in sediment PAH indicates that the zone of greatest contamination is confined to an area within 150m to 200m of the dock, depending on the transect line. Within this area sediment "hotspots" can be identified, and these are generally confined to the zone within 75m along the north face of the dock and 100 m along the northern 100m of the east face. Contaminant levels to the southeast and east were generally much lower, even close to the dock, and indicate that this area has remained relatively uncontaminated by comparison. The exception is a small zone around station T-5.5s-25m where sediment concentrations exceeded 150 ppm of total PAH. Based on sediment surficial concentrations, the zone of high PAH contamination along the east face extends as far south as transect line T-DE (Figure 29).

Along the north face, two hotspots were identified. The first is the zone of visible contamination in the area of the pool (transect line T-5). It is not clear whether this area represents deposition of new material since the removal of the creosote pools undertaken in 1989, or whether this area was missed during the earlier cleanup. Encompassing this area is a zone where contaminant concentrations exceeded 200 ppm of total PAH, and this area extended from less than 50m to nearly 100m from the dock, depending on the transect line (see Figure 29). Concentrations found at the various distances are plotted on Figure 28.

Analysis results indicate that the only other contaminants of concern in the study area are dioxins and furans. These are present as impurities in chlorophenols, and this represents the most likely source for these compounds. Dioxins and furans were present in sediments primarily as the higher chlorinated compounds (hexa to octa chlorinated forms with the octa- forms predominating). Concentration profiles in sediment were similar to those for PAH and show highest concentrations close to the dock along the north and east transects, with lower levels along the southeast transect. Concentrations, particularly of the hepta- and octa- dioxins were high close to the dock (within 25 m along transect T-EF) and decreased rapidly, such that by 75 m and 100m respectively (Figures 13 and 30), concentrations along transect T-EF were

below the draft No Effect Level guidelines (see Appendix B). Contamination to above the NEL extended further out along transect T 5.5 such that by 150m (1,2,3,4,6,7,8-H7CDD) and 125m (O8CDD), concentrations were below the NEL. It should be noted that exceedance of the NEL does not suggest a toxic effect would be present, but does indicate that bioaccumulation and biomagnification could be a concern. The compounds present were primarily the higher chlorinated forms, which are characterized by high Kow (log Kow ranges from 7 to 8) and large molecular structure. Since these compounds partition strongly to sediment, their availability to organisms would be relatively low. In addition, the large size of the molecules generally reduces availability for uptake to below levels predicted based on partitioning estimates (Smith *et al.* 1988) since these molecules do not readily pass through cell membranes.

Concentrations exceeded the draft No Effect Level guidelines for only two compounds: octachlorodibenzo-p-dioxin and 1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin. The area of exceedance for these compounds matched the area of highest PAH contamination. Both were confined to within 125 m of the dock along the north side (transect T-5.5) and within 100m of the northern part of the east side (transects T-7/9 and T-EF) (Figure 30). Concentrations along transect T-DE were generally lower and below the NEL guidelines for the octa-dioxin, though concentrations were slightly above the NEL guideline for 1,2,3,4,6,7,-heptachlorodibenzo-p-dioxin. Total TEQs for dioxins and furans suggest that there is high bioaccumulation potential associated with sediments within 50m of the dock along transects T-EF and T-7/9, and within 75m of the dock along transect line T-5.5. These sediments could be a potential source of dioxins and furans to biota.

Beyond these distances, concentrations were below the respective draft No Effect Levels and suggest that there would be little toxic potential associated with these sediments, at least due to these compounds. Since the No Effect Level is based upon Provincial Water Quality Objectives, which consider the bioavailability and biomagnification potential of a compound, the No Effect Level is expected to provide protection against bioaccumulation from sediments (Persaud *et al.* 1993).

The presence of pentachlorophenol in sediments may be due to the nature of the plant operations, since PCP typically does not accumulate in sediments (chlorophenols are weak acids and tend to ionize in water). However, its presence in solvents used as a carrier for wood treatment may bind this otherwise soluble compound and could account for its presence in sediments. Seepage from the site could result in deposition of this material in the sediment. This could also be the mode through which dioxins and furans are entering the aquatic environment (i.e., through seepage from the site). The dispersal pattern of these compounds in the harbour area is then likely a factor of both the nature of the solvent and the resuspension of fine-grained sediment.

The benthic communities within the 100m zone showed no effects that could be attributed to sediment PAH concentrations, with the exception of the chironomids. Along transects T-5.5 and T-7/9, stations close to the dock (25 m) had significantly fewer chironomids and fewer taxa. Since

substrate type and depth was relatively uniform along these two transects, the most likely factor was the increase in sediment total PAH concentrations (chironomid density did show a weak negative correlation with sediment total PAH). A simple regression of density versus sediment total PAH suggests that a 50% reduction in chironomids would correspond to approximately 150 ppm total PAH in sediment.

Benthic community structure analysis indicated that beyond the 100m zone, the benthic community as a whole did not show any direct effects of high sediment concentrations of PAH. Since much of the PAH is present as discrete blobs or drops of oil, it would be relatively easy for most organisms to avoid these areas. This could account for the lack of response to higher PAH concentrations in many organisms. As noted, the distribution of the chironomid fauna does show a correlation with sediment contaminant levels along the north transect T-5.5, and the north-east transect T-7/9, and suggests that sediment PAH is affecting these organisms. As Figure 20 shows, decreases in sediment total PAH concentrations are matched by increases in density of chironomids. The effects on chironomids suggest that below 30 ppm total PAH, there is no noticeable reduction in density.

Sediment bioassay test results indicate that there is an increase in both mortality and growth impairment in chironomids and, to a lesser extent, in mayflies, in those sediments close to the dock. Chironomid mortality was slightly higher in sediments within 150m of the dock (T-5.5), and growth was impaired in these sediments. At a distance of 175m both growth and mortality were similar to the control. A similar though less pronounced effect was apparent on the mayflies. Mayflies generally suffered less mortality in these sediments, though growth was still impaired in sediments up to 150m from the dock. In sediments collected at 175m there was no detectable difference between the control and stations further out along transect T-5.5. Sediment concentrations in both bioassay sediments and surficial sediments were similar at 175m and were just below 30 ppm total PAH.

Therefore, at 30 ppm total PAH, there appeared to be no effect on these organisms relative to the control stations. As noted earlier, sediment bioassays tend to exemplify the worst conditions. The process of preparing the sediments results in more complete mixing of the contaminants throughout the sediment, and also potentially heightens the bioavailability of the compounds though disturbance of the sediment. Therefore, this test in effect simulated expected responses under dynamic conditions where mixing, resuspension and deposition would occur. As a result, it appears from these test results that sediment up to and including 30 ppm total PAH could be left in place with no negative effects on benthic communities.

Within the 100m zone, the sediment bioassay results indicate that some of the sediments, particularly those close to the dock (25m, 50m and 75m) along transect T-5.5 were acutely toxic to both mayflies and chironomids (Figure 21). A similar result was obtained along transect T-EF within 25m of the dock (Figure 22).

Sediments further out showed reduced toxicity to mayflies and

chironomids, but there was still an inhibition of growth associated with these sediments (Figure 23). As noted above, only at station T-5.5-175m, where concentrations in sediment were near 30ppm total PAH, did growth rates increase. Growth rates for both mayflies and chironomids stayed high and equalled or exceeded levels at the control from 175m to 500m.

Minnow results from the Phase II study indicate that there was an increase in mortality at some stations within 100m of the dock. Along both transects T-5.5 and T-EF, mortality was highest at those locations where sediment total PAH concentrations were highest (i.e., 25m along T-EF and 75m along T-5.5).

Minnow results were inconclusive from the Phase I studies, particularly since the sediments with higher PAH concentrations did not result in a toxic effect, while sediments further out apparently did result in some mortality (Figure 25). It is likely that some other factor, rather than sediment PAH concentrations is likely for the reduced mortality. The data suggest that innate variability in the batches of test organisms used may have been responsible for these apparently anomalous results.

The bioaccumulation data showed a gradient of PAH accumulation by fathead minnows such that locations close to the dock resulted in higher tissue residues. By 175m north from the dock, there were no detectable levels in minnow tissues. Analysis of the data showed a significant correlation between tissue residues and sediment total PAH.

Figures 24 and 25 show the test results for the chironomid and mayfly toxicity tests plotted against surficial sediment PAH concentrations (total PAH). Both the mayfly and the chironomid mortality data indicate that there was an increase in mortality with increasing sediment total PAH concentrations. From the curves, it appears that the area of greater than 50% mortality for both chironomids and mayflies coincides with a concentration of total PAH of approximately 150 ppm (conservative estimate). Regression analysis found that 50% mortality among the chironomids coincided with the 150 ppm concentration of total PAH (upper 95% confidence limit) while the area of 50% mortality of mayflies coincides with approximately 130 ppm total PAH (upper 95% confidence limit).

Based on the above evaluation of sediment concentrations and biological effects, three primary zones were identified. The first, representing the most contaminated conditions, was the area of heavy, visible contamination of sediments by creosote. This is the area along transect line T-5 and was found to include the 50 m distance, but did not extend to the 75m distance. Since transects on either side (T-4.5 and T-5.5) of T-5 did not yield significant quantities of creosote in the sediment samples this area appears to be confined to less than 50m on either side. Cleanup of this area should proceed based on visual observation of creosote on the sediment surface. This area represents a continual source of creosote (and PAH contamination) to both the water column and adjacent sediments. The approximate boundary of this zone is shown in Figure 29.

The second zone can be defined on

the basis of acute biological effects i.e., greater than and including 50% mortality in the test organisms, and coincides with the area of high PAH (>150 ppm) and dioxin/furan contamination (>200 ppt total TEQ, which coincides approximately with the NEL for OCDD of 69 ppb). This area should be isolated since the toxic potential of these sediments is very high. The approximate boundary of this zone is shown in Figure 29 as the area enclosed within the 150 ppm total PAH isopleth.

The third zone can be defined on the basis of chronic biological effects and coincides with the sediment area exceeding 30 ppm of total PAH. This area is shown in Figure 29 as the area enclosed within the 30 ppm total PAH isopleth, and represents the area where contaminated sediments should be confined in order to minimize contaminant effects on aquatic biota. Below this concentration, there appears to be no effect on benthic organisms.

Both contaminant concentrations and biological effects are low or not apparent in those areas below 30 ppm, and this area would be suitable for natural remediation since existing contaminant concentrations pose little threat to biota. The results of this study indicate that in most of this area, there has been deposition of cleaner material on the surface, as well as a general reduction of contaminant concentrations since the previous survey conducted in 1987 by Beak. Active deposition of new material would serve to effectively isolate the relatively more contaminated sediments in the deeper layer and would permit longer term degradation of contaminants in this area with little concern regarding potential exposure to aquatic organisms.

5.0 Conclusions

1. PAH concentrations were highest along the north and east sides of the dock. Concentrations decreased rapidly, such that in most cases concentrations in surficial sediments had decreased by an order of magnitude within 100 meters of the dock.

2. Concentrations in surficial sediments were generally lower than in subsurface sediments. Higher sediment concentrations of total PAH were found in core and bioassay samples, which sample up to 20-30cm deep (vs. 5cm for surficial sediments) within 150 m of the dock along both the north and east sides. Beyond this distance concentrations in the cores, bioassay sediments, and surficial sediments were very similar and indicate that there is much less subsurface contamination in this area.

3. Concentrations of chlorophenols were generally below detection limits with the exception of pentachlorophenol. Concentrations of PCP were generally low (up to 80 ppb) but followed a distribution pattern similar to that noted for PAH. In effect, this means that the remediation option chosen for PAH will also address the PCP contamination.

4. Concentrations of PCB and organochlorine pesticides were generally below detection limits throughout the study area.

5. Concentrations of PCDD/Fs in sediment indicate that mainly the highly chlorinated compounds (hexa- hepta- and octa- dioxins and furans) were present in the sediments. Distribution patterns of these compounds in the study area were similar to distribution of PAHs. Concentrations close to the dock were above published or draft guidelines. Levels are therefore of some concern, but since the area of greatest contamination coincides with the area of greatest PAH contamination, this problem will also be addressed through remediation of the PAH problem.

6. Benthic community structure within the zone 100m zone showed significant reductions in both density and diversity of chironomids, and suggests that sediment total PAH concentrations may be having an effect on these organisms. Regression analysis suggests that a 50% reduction in density of these organisms correspond to a sediment total PAH concentration of approximately 150 ppm. None of the other major benthic groups appeared to be affected.

7. Benthic communities beyond the 100m zone did not show a specific response to PAH contamination of the sediments, with the exception of the chironomids. Density of chironomids showed a weak correlation with elevated PAH concentrations, and suggests that these organisms are responding negatively to elevated sediment PAH. Concentrations below 30 ppm total PAH generally did not elicit a negative response.

8. Sediment bioassay results indicate that acute effects on benthic organisms were apparent within 100m of the dock. The results indicate that within the zone where sediment concentrations were above 150 ppm of total PAH, there was greater than 50% mortality of both mayflies and chironomids.

9. Sediment bioassay results indicate that beyond 150m along transect line T-5.5, negative responses among the test organisms are not apparent. Up to 150 m, mortality increased among the chironomids and mayflies, while growth of the surviving organisms was reduced. Within 150m of the dock there was also uptake of PAH compounds by the fathead minnows, suggesting that there is potential release of these compounds to the water column. At the 175m distance, where sediment total PAH concentrations decreased to 30 ppm there was no apparent effect on any of the test organisms. There was no accumulation of PAH in minnow tissues in sediment collected at 175m or beyond.

6.0 Recommendations

1. *The areas of total PAH concentrations up to and including 30 ppm could be left in place with no anticipated negative effects on benthic organisms. There is also no expected effect on water column organisms at this concentration.*

Rationale:

There were no effects on either resident benthic organisms or on the laboratory test organisms at concentrations below 30 ppm.

Changes in concentrations of total PAH from 1988 to 1995 indicate there has been a reduction in total PAH. This trend would be expected to continue, resulting in a general reduction in PAH concentrations over time in those areas. The higher subsurface concentrations of PAH indicate that burial of material has taken place.

The relatively confined distribution of PAH in sediment suggests the material is not readily dispersed. This combined with the deposition of new sediment would serve to further confine the contaminated sediment and coupled with the lack of biological effects would make this area a suitable candidate for natural remediation. Therefore, the area up to and including 30 ppm total PAH in sediment should be left undisturbed.

2. *Sediment exceeding 30 ppm total PAH should be confined to minimize adverse effects and reduce the potential for dispersal of this material.*

Rationale:

Effects on benthic organisms were confined to the chironomids within the zone 100m from the dock and the 30 ppm total PAH isopleth. Sediment bioassay tests indicate that sediment exceeding 30 ppm of total PAH resulted in increased mortality and reduced growth as well as potential release of PAH compounds to the water column, and this area represents a potential hazard to aquatic life.

3. *Sediment exceeding 150 ppm of total PAH should be adequately confined or removed since at present it presents a hazard to aquatic life.*

Rationale:

Sediments exceeding 150 ppm of total PAH had pronounced negative effects on benthic organisms (i.e., acute mortality and/or severe reductions in benthic community diversity or density). This area also coincides with significant dioxin contamination, and removal or isolation of these sediments would reduce the risk of bioaccumulation and biomagnification of these compounds from sediment sources. This material needs to be effectively confined, such that there is no risk of transport of the contaminants. If this cannot be attained, then long-term monitoring of the area and contingency plans for future remediation, if this becomes necessary, need to be considered.

4. *The area of significant creosote contamination along transect line T-5, and to either side, should be removed.*

Rationale:

This material cannot be easily confined, and represents a significant potential source of future contamination, especially through seepage. Cleanup of this area should be based on visual assessment of the area.

7.0 REFERENCES

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Appendix A

Detailed Methodology for Laboratory Sediment Bioassay Testing

A1.0 MATERIALS AND METHODS

A1.1 Sample Collection and Site Description

Surficial sediment was collected for the completion of laboratory sediment bioassays during the summer and fall surveys. Collection was made using a Ponar grab sampler. At each sample location, approximately 10 L of composited surficial sediment (approx. 20-25 cm) was collected from several grabs. Additional sediment was collected at those sites containing relatively high volumes of bark material. The composited sediment was placed into 20 L plastic buckets lined with food-grade polyethylene bags and transported to the Toronto, Ontario laboratory where they were stored in the dark, at 4°C until required.

During the week of July 17, 1995, 10 test sediment samples were collected along transect T-5.5, following a gradient that started from 100 metres (Station T5.5-100 m) and extended to 500 metres (Station T5.5-500 m) (Fig. 5). In the next survey, 3 test sediments were collected on September 26, 1995, along two transects (T5.5 and TEF) at 25, 50 and 75 metre intervals (Fig. 5). On both occasions, a reference control sediment was sampled at a location situated east of the shipping channel. The reference control sediment should be representative of naturally occurring background contamination levels for the study area and be physically similar to the test sediments to help discriminate effects due to physical or chemical causes. Sediment collected from Honey Harbour in Georgian Bay served as a 'negative control' for each bioassay. The negative control sediment is a relatively uncontaminated sediment that provides a measure of test acceptability. Both control sediments are a basis for comparing the biological responses from the test sediments.

A1.2 Analytical Methods

Chemical analysis of sediment and biota samples was carried out by the MOEE, Laboratory Services Branch, located in Toronto. Detailed methodology is described in the *OMOE Handbook of Analytical Methods for Environmental Samples* (OMOE, 1983). Quality assurance procedures included method blanks, spikes, duplicates and standard reference materials.

Sediment Nutrients and Particle Size Characterization

Homogenized bulk sediment (<2 mm fraction) was measured for total phosphorus (TP), total Kjeldahl nitrogen (TKN) and percent weight loss on ignition (LOI) which measured approximate organic content. Sediment total organic carbon (TOC) was determined with a LECO carbon analyzer using a dry combustion technique which oxidized carbon to CO_2. Particle size was measured on 50 g, air-dried samples using a Microtrac particle size analyzer for the size range 1.00 mm to 0.1 μm. This was to provide data for %sand (2mm -62 μm), %silt (62- 3.7 μm) and %clay (3.7 - 0.1 μm) size classes.

Trace Metals in Sediment

Prepared sediment samples were digested using a concentrated aqua-regia acid mixture (1 part HNO_3 to 3 parts HCl). The dissolved trace metals including As, Cd, Cr, Cu, Fe, Pb, Mn, Ni and Zn in the digestates were detected by inductively coupled argon plasma atomic emission spectroscopy (ICP-AES) and Hg by flow injection vapour generated flameless atomic absorption spectroscopy (AAS).

Organic Chemicals in Sediment

Moist sediment samples were extracted with acetone and dichloromethane. The extract was transferred to a rotary evaporator, concentrated and fractionated on a Florisil column. Different solvent combinations were used to elute the extracts into three groups, Fraction A1 contained total PCBs, 5 Aroclor groups, hexachlorobenzene, heptachlor, aldrin, octachlorostyrene, pp-DDE and mirex. Fraction A2 contained a- & b-BHC, a- & b-chlordane, op-DDT, pp-DDD, pp-DDT and fraction A3 included heptachlor epoxide, oxychlordane, dieldrin, endosulfan I & II, endosulfan sulphate, endrin and methoxyclor. Analytes were identified and quantified using capillary gas chromotagraphy equipped with a Ni^{63} electron capture detector (GLC-ECD).

Organic Chemicals and Percent Lipid in Biota

Pooled whole fish samples (~5g) were thawed, homogenized and acid digested using concentrated HCl acid on duplicate samples per sediment. The digestate was reacted with a mixture of 25% dichloromethane in hexane. The extract was treated with sodium bicarbonate to ensure neutralization and dried with anhydrous sodium sulphate. Sample clean-up and detection followed identical procedures as those described for sediment analysis. Final results are reported on a wet weight basis for 16 compounds (Table 1A). Percent lipid was determined on an aliquot (25 ml) of the final extract obtained prior to clean-up. The solvent was allowed to evaporate by air-drying in a fumehood for 24 hours and lipid residues were measured.

A1.3 Laboratory Biological Testing Methods

Basic Experimental Design

Sediment biological tests were conducted according to MOEE standardized procedures (Bedard *et al.*, 1992) and are briefly described below. The bioassays were static, single-species tests using whole-sediment. The experimental unit was a 1.8 L test chamber containing prepared sediment and dechlorinated municipal tap water (1:4, v:v). The chambers were randomly placed into a holding tank at ambient room temperature and maintained under a 16:8 hour, light:dark photoperiod and continuous aeration.

Moist field-collected bottom sediment was pressed through a 2-mm stainless-steel sieve to remove existing large biota and debris prior to use. Work was completed from July 26 - 28

for the July survey and from October 5 - 10 for the September survey. Subsamples of this homogenized sediment were submitted for chemical and physical characterization according to standard MOEE procedures (OMOE, 1989). The sieved sediment was homogenized with a spatula and stored in 4 L acid-rinsed glass jars until required. Three hundred and twenty-five millilitre aliquots of homogenized sediment were placed into the test chamber and overlaid with the test water. After settling overnight, the chambers were aerated continuously until the termination of the test. A clean, negative control sediment that was collected from Honey Harbour, Georgian Bay, was used for each bioassay. Control mortality must not exceed 15% for mayflies and fathead minnows and 25% for chironomids or the test is declared invalid.

Water in the exposure chambers was regularly monitored for pH, conductivity, total ammonia, un-ionized ammonia and dissolved oxygen. Dead organisms were removed and the numbers recorded on a daily basis. Any signs of abnormal behaviour of the test organisms or changes in appearance of the test chambers were noted. Water loss due to evaporation was replenished as needed. At the conclusion of the test, fathead minnow test organisms were collected, placed into glass vials and frozen prior to analysis. The whole body tissue samples were measured for 16 PAH compounds and percent lipid on single samples.

Hexagenia limbata Lethality and Growth Assay

The first set of toxicity tests used 4 month old laboratory reared mayfly nymphs with an average wet weight of 4.77 mg $\pm$ 0.38 (s.e.). The second round of toxicity tests used 4.8 month old nymphs with an average wet weight of 6.69 mg $\pm$ 0.41 (s.e.). The nymphs were raised from eggs collected by Dr. J. Ciborowski at the University of Windsor, Windsor, Ontario. Mayflies were reared according to MOEE procedures (Bedard *et al.*, 1992) and methods described in the literature (Friesen, 1981).

The rearing procedure involved the transfer of 600 newly-hatched nymphs to a 6.5 L aquarium which contained 2 cm of autoclaved sediment and 5.6 L dechlorinated tap water. Animals were maintained at ambient room temperature, 16:8 hour, light:dark photoperiod, constant aeration and fed a vegetable diet.

Test organisms were retrieved from the rearing aquaria by sieving small portions of sediment in a 500-μm mesh brass sieve. The nymphs were washed into an enamelled tray which held a fine mesh sieve and aerated, dechlorinated water. A Pasteur pipette (5-mm opening) was used to transfer the mayflies into 100 mL beakers of water and the contents were gently poured into the test chambers. Three replicates were run for each sediment and ten nymphs were added for each replicate, for a period of 21 days. During sorting, 40 and 44 individuals were randomly selected and weighed individually to the nearest 0.01 mg to obtain the starting weight for the first and second series of toxicity tests, respectively, and then discarded. Animals were not fed during the length of the test.

At the end of the test, the contents of each test chamber were emptied and rinsed in a sieve bucket. Surviving animals were counted and transferred to 150 mL beakers holding 100 mL dechlorinated water. The nymphs were immobilized with Alka-Seltzer®, blotted dry and

individuals weighed to the nearest 0.01 mg, placed in vials and stored in a freezer.

Chironomus tentans Lethality and Growth Assay

The tests used 10-12 day old, cultured chironomid larvae weighing an average wet weight less than 1 mg. The MOEE continuously cultures *C. tentans* larvae from egg to adult following standard methods (Bedard *et al.*, 1992, Mosher *et al.*, 1987, Townsend *et al.*, 1981). Egg masses were acquired from Dr. J. Giesy at Michigan State University, Lansing, Michigan and have been cultured for several generations in our laboratory.

Initially, the midges were reared in enamelled trays for a period of 10 to 12 days and then maintained in a 21 L aquarium containing 1.6 L of silica sand. The cultures were held at ambient room temperature with continuous aeration and under a 16:8 hour, light:dark photoperiod. The larvae were provided a vegetable diet *ad libitum*.

Second instar larvae were directly transferred from the enamelled rearing pans into the test chamber using the 5-mm opening of a Pasteur pipette. A total of 15 animals were added per chamber to each of the four replicates in the second set of toxicity tests and three replicates were used in the first toxicity test. Animals were fed daily 30 mg of a Cerophyll®:Tetra Conditioning Vegetable® (3:2, w:w) diet. Within 18 hours the jars were checked and "floaters" were removed and replaced.

After 10 days, the contents of the test chambers were emptied and washed in a sieve bucket. Surviving animals were sorted, removed and placed into 150 mL beakers holding 100 mL dechlorinated water and 15 mL silica sand. The larvae were counted, blotted dry and individuals weighed to the nearest 0.01 mg.

Pimephales promelas Lethality and Bioaccumulation Assay

The tests used cultured, juvenile fathead minnows that weighed 360 mg $\pm$ 26 and 499 mg $\pm$ 30 (s.e.) (wet weight), for the first and second series of toxicity tests, respectively. The minnows were cultured at the MOEE laboratory and followed techniques which for the most part are US EPA procedures (USEPA, 1987) with minor revisions (Bedard *et al.*, 1992).

Cultures were maintained at 25°C in a flow-through dechlorinated water system and under a 16:8 hour, light:dark photoperiod. Breeders were kept in 60 L glass aquarium and eggs are laid on spawning tiles. The tiles were incubated in a 25°C water-bath and the developing larvae were transferred to 400 L fibreglass holding tanks. Larval fish were fed 48-hour old live brine shrimp while juveniles and breeders were provided frozen brine shrimp. Each size class was fed *ad libitum*.

Each test chamber received 10 juvenile minnows for each of the three replicates. The minnows were sorted into 250 mL glass beakers in groups of five. The contents of the beakers were emptied into a small net and the minnows released into the test chamber. During sorting

a random subsample of 30 animals was separated, weighed individually and frozen.

The minnows were exposed for 21 days and fed Tetra Conditioning Vegetable® diet in an amount equivalent to 1% of the average starting wet weight, on a daily basis. After 21 days the surviving fathead minnows were pooled from each replicate, counted, immobilized with Alka-Seltzer® and placed into 30 mL glass vials and frozen pending chemical analysis.

Reference Toxicant Testing

A water-only reference toxicity ($CuSO_4$) test was conducted with *H. limbata* and *C. tentans* for 48-hours and LC50s were calculated. The static tests consisted of four test concentrations and a control. The nominal copper concentrations were 0.05, 0.25, 0.5, 1 and 3 mg/L. Ten mayfly nymphs or midge larvae were placed into each of four replicate 250 mL beakers. To help reduce stress, five glass tubes were placed into the mayfly test beakers and a fine layer of silica sand was added to the midge test containers. Mortality was monitored every 24 hours and water quality parameters were taken at 0 and 48 hours. The mayfly test for the first toxicity test, used 4 month old laboratory reared mayfly nymphs with an average wet weight of 7.12 mg $\pm$ 0.51 (s.e.). The mayfly test for the second toxicity test, used 5 month old laboratory reared mayfly nymphs with an average wet weight of 5.44 mg $\pm$ 0.52 (s.e.). The midge larvae were 10-12 day post-hatch with an average wet weight $<$ 1 mg.

Bioassay Schedule for July 1995 (Phase I) sediment samples.

Test Organism	Species	Starting Date ('95)	Completion Date ('95)	Test Duration
Mayfly	*Hexagenia limbata*	Wed. August 2	Wed. August 23	21 days
Chironomid	*Chironomus tentans*	Fri. August 4	Mon. August 14	10 days
Minnow	*Pimephales promelas*	Thur. August 10	Thur. August 31	21 days

Bioassay Schedule for September 1995 (Phase II) sediment samples.

Test Organism	Species	Starting Date ('95)	Completion Date ('95)	Test Duration
Mayfly	*Hexagenia limbata*	Thur. October 12	Thur. November 3	21 days
Chironomid	*Chironomus tentans*	Tue. October 24	Fri. November 3	10 days

Test Organism	Species	Starting Date ('95)	Completion Date ('95)	Test Duration
Minnow	*Pimephales promelas*	Fri. November 17	Fri. December 8	21 days

A1.4 Statistical Methods

Statistical analyses were performed using SAS® software package (SAS, 1985). Comparisons were made among the test and control sediments using One-Way Analysis of Variance (ANOVA) and Tukey's studentized range test (HSD) and planned comparisons (Steel and Torrie, 1960). Dunnett's *t*-test was used solely to compare mortality between the control and test sediments. Analysis was made on arc-sine transformed mortality data. Homogeneity of variance across groups was tested using Bartlett's test. Coefficients of variation (C.V. %) were calculated for each endpoint as a measure of test precision. LC50's (including the associated 95% confidence limits) were calculated using software developed by Stephan (1977) and were derived by probit analysis. Further statistical analysis will be completed to investigate the correlation among the different biological endpoints for each species and sediment characteristics.

Appendix B

Interim Sediment Quality Guidelines for Dioxins and Furans

Interim Sediment Quality Guidelines for Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans

Compound	$\log K_{oc}$	WQC	I-TEF	Guideline	Effect Level
2,3,7,8-T_4CDD	6.83	0.06 pg/L	1	4.06 ppt	No Effect Level
1,2,3,7,8-P_5CDD	7.27	0.06 pg/L	0.5	55.9 ppt	No Effect Level
1,2,3,4,7,8-H_6CDD	7.67	0.06 pg/L	0.1	280 ppt	No Effect Level
1,2,3,6,7,8-H_6CDD	7.58	0.06 pg/L	0.1	2.28 ppb	No Effect Level
1,2,3,7,8,9-H_6CDD	6.69	0.06 pg/L	0.1	29.4 ppt	No Effect Level
1,2,3,4,6,7,8-H_7CDD	7.86	0.06 pg/L	0.01	4.34 ppb	No Effect Level
O_8CDD	8.06	0.06 pg/L	0.001	68.9 ppb	No Effect Level
2,3,7,8-T_4CDF	6.56	0.06 pg/L	0.1	21.8 ppt	No Effect Level
1,2,3,7,8-P_5CDF	7.67	0.06 pg/L	0.05	1400 ppt	No Effect Level
2,3,4,7,8-P_5CDF	7.32	0.06 pg/L	0.5	62.6 ppt	No Effect Level
1,2,3,4,7,8-H_6CDF	7.57	0.06 pg/L	0.1	223 ppt	No Effect Level
1,2,3,6,7,8-H_6CDF	7.47	0.06 pg/L	0.1	180 ppt	No Effect Level
1,2,3,7,8,9-H_6CDF 2,3,4,6,7,8-H_6CDF	6.88	0.06 pg/L	0.1	45 ppt	No Effect Level
1,2,3,4,6,7,8-H_7CDF	8.28	0.06 pg/L	0.01	11.4 ppb	No Effect Level
1,2,3,4,7,8,9-H_7CDF	6.78	0.06 pg/L	0.01	362 ppt	No Effect Level
O_8CDF	8.2	0.06 pg/L	0.001	95 ppb	No Effect Level

Given the lack of additional guideline levels, site-specific assessment of biological effects should be conducted to determine the severity of contamination where:

1) Sediment concentrations of 2,3,7,8-T_4CDD exceed the No Effect Level guidelines.

2) Where only a few of the compounds have been detected, the individual PCDDs or PCDFs exceed the No Effect Level guidelines.

3) The total 2,3,7,8-T_4CDD TEQ for all compounds exceeds the NEL for 2,3,7,8-T_4CDD.

Tables

Table 1: Thunder Bay - Northern Wood Preservers. Field Sampling Details and Sediment Description. July 17-20, 1995

Transect & Distance	Sample type(s)	Water Depth	Description	Oil - Surface	Oil - sub-surface	Chemical Analysis	Biological Analysis
Transect Line T-5N							
T-5N 100m (Beak Stn G5)	Core samples (3): 20.5 cm Rep 1 - 33.5 Rep 2 - 30.7 Rep 3 - 18.3	6 m	Surface layer of light brown fine-grained flocculent material approx. 5 mm thick. Silt/clay and clay deeper layers. Some wood waste in subsurface layers. Oil droplets in sediment.	Yes	Yes	PAH & Nutrients	None
T-5N 150m (Beak Stn GG5)	Core samples (3): 10 cm Rep 1 - 19.3 Rep 2 - 33.1 Rep 3 - 29	3 m	Surface layer of light brown fine-grained flocculent material approx. 5 mm thick. Silt/clay and clay deeper layers. Some wood waste in subsurface layers. Some oil droplets in sediment.	No	Yes	PAH & Nutrients	None
T-5N 200m (Beak Stn H5)	Core samples (3): 20 cm Rep 1 - 23.8 Rep 2 - 28 Rep 3 - 43.5	3 m	Surface layer of light brown fine-grained flocculent material approx. 5 mm thick. Silt/clay and clay deeper layers. Some wood waste in subsurface layers. No visible oil in sediment.	No	No	PAH & Nutrients	None
T-5N 250m (Beak Stn HH5)	Core samples (3): 22 cm Rep 1 - 21.6 Rep 2 - 15.5 Rep 3 - 14.2	2.6 m	Surface layer of light brown fine-grained flocculent material approx. 5 mm thick. Silt/clay and clay deeper layers. Very little wood waste in subsurface layers. No visible oil in sediment.	No	No	PAH & Nutrients	None
T-5N 300m (Beak Stn I5)	Core samples (3): 21.5 cm Rep 1 - 26.8 Rep 2 - 20 Rep 3 - 19.8	3 m	Surface layer of light brown fine-grained flocculent material approx. 5 mm thick. Silt/clay (primarily silt) and clay deeper layers. No visible oil in sediment.	No	No	PAH & Nutrients	None
T-5N 350m (Beak Stn II5)	Core samples (3): 23 cm Rep 1 - 16.5 Rep 2 - 17.7 Rep 3 - 23.5	2.6 m	Surface layer of light brown fine-grained flocculent material approx. 5 mm thick. Silt/clay (primarily silt) and clay deeper layers. No visible oil in sediment.	No	No	PAH & Nutrients	None
T-5N 400m (Beak Stn J5)	Core samples (3): 27 cm Rep 1 - 12.0 Rep 2 - 17.0 Rep 3 - 16.4	3 m	Surface layer of light brown fine-grained flocculent material approx. 5 mm thick. Silt/clay (primarily silt) and clay deeper layers. No visible oil in sediment.	No	No	PAH & Nutrients	None
T-5N 500m (Beak Stn K5)	Core samples (3): 37.5 cm Rep 1 - 43.2 Rep 2 - 44 Rep 3 - 54.5	3 m	Surface layer of light brown fine-grained flocculent material approx. 5 mm thick. Silt/clay (primarily silt) and clay deeper layers. No visible oil in sediment.	No	No	PAH & Nutrients	None
Transect Line T-5.5							

Transect & Distance	Sample type(s)	Water Depth	Description	Oil - Surface	Oil - sub-surface	Chemical Analysis	Biological Analysis
T-5.5 100m	Ponar samples Sediment - comp/3 Benthos - 3 reps Sed. bioessay	3.5 m	Surficial layer of light brown flocculent material (1-2 cm) overlying 5-7 cm of silt/clay. Surface vegetation. Large amount of bark beginning at the surface. Dense bark layer approx. 5-7 cm down. Oil in bark layer as well as some surface oil.	Yes	Yes	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm. Sed. bioassay Art.sub./tissue residue.
T-5.5 125m	Ponar samples Sediment - comp/3 Benthos - 3 reps Sed. bioessay	3.3 m	Surficial layer of light brown flocculent material (1-2 cm) overlying 5-7 cm of silt/clay. Surface vegetation. Dense bark layer approx. 5-7 cm down. Oil in subsurface layer beginning ca. 2-3 cm down.	No	Yes	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm. Sed. bioassay
T-5.5 150m	Ponar samples Sediment - comp/3 Benthos - 3 reps Sediment bioassay	3.0 m	Surficial layer of light brown flocculent material (1-2 cm) overlying 5-7 cm of silt/clay. Some surface vegetation. Dense bark layer approx. 5-7 cm down. Some oil in subsurface layer beginning ca. 2-3 cm down.	No	Yes	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm. Sed. bioassay Art.sub./tissue residue.
T-5.5 175m	Ponar samples Sediment - comp/3 Benthos - 3 reps Sediment bioassay	3.7 m	Surficial layer of light brown flocculent material (1-2 cm) overlying 5-7 cm of silt/clay. Dense surface vegetetion. Dense bark layer approx. 5-7 cm down. Few small drops of oil in surface layer. Oil mainly in bark layer (5+ cm).	Yes	Yes	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm. Sed. bioassay
T-5.5 200m	Ponar samples Sediment - comp/3 Benthos - 3 reps Sediment bioassay	3.7	Surficial layer of light brown flocculent material (1-2 cm) overlying 5-7 cm of silt/clay. Dense surface vegetation. Bark layer approx. 5-7 cm down. Few small drops of oil in surface layer. Oil mainly in bark layer (5+ cm).	Yes	Yes	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm. Sed. bioassay Art.sub./tissue residue.
T-5.5 225m	Ponar samples Sediment - comp/3	3.7 m	Surficial layer of light brown flocculent material (1-2 cm) overlying 5-7 cm of silt/clay. Deeper layers below 5-7 cm mainly soft grey clay. Some surface vegetation. No visible oil.	No	No	PAH & Nutrients	None
T-5.5 250m	Ponar samples Sediment - comp/3 Benthos - 3 reps Sediment bioassay	3.7 m	Surficial layer of light brown flocculent material (1-2 cm) overlying 5-7 cm of silt/clay. Deeper layers below 5-7 cm mainly soft grey clay. Some surface vegetation. Some bark beginning at -5 cm. No visible oil.	No	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm. Sed. bioassay Art.sub./tissue residue.

Transect & Distance	Sample type(s)	Water Depth	Description	Oil - Surface	Oil - sub-surface	Chemical Analysis	Biological Analysis
T-5.5 275m	Ponar samples Sediment - comp/3	3.7 m	Surficial layer of light brown flocculent material (1-2 cm) overlying 5-7 cm of silt/clay. Deeper layers below 5-7 cm mainly soft grey clay. Little surface vegetation. No bark or visible oil.	No	No	PAH & Nutrients	None
T-5.5 300m	Ponar samples Sediment - comp/3 Benthos - 3 reps Sediment bioassay	3.7 m	Surficial layer of light brown flocculent material (1-2 cm) overlying 5-7 cm of silt/clay. Deeper layers below 5-7 cm mainly soft grey clay. Little surface vegetation. No bark though small amount of visible oil below 2.5 cm.	No	Yes	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm. Sed. bioassay Art.sub./tissue residue.
T-5.5 350m	Ponar samples Sediment - comp/3 Benthos - 3 reps Sediment bioassay	3.3 m	Surficial layer of light brown flocculent material (1-2 cm) overlying 5-7 cm of silt/clay. Deeper layers below 5-7 cm mainly soft grey clay. No surface vegetation. No bark or visible oil.	No	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm. Sed. bioassay
T-5.5 400m	Ponar samples Sediment - comp/3 Benthos - 3 reps Sediment bioassay	3.7 m	Surficial layer of light brown flocculent material (1-2 cm) overlying 5-7 cm of silt/clay. Deeper layers below 5-7 cm mainly soft grey clay. No surface vegetation. No bark or visible oil.	No	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm. Sed. bioassay Art.sub./tissue residue.
T-5.5 500m	Ponar samples Sediment - comp/3 Benthos - 3 reps Sediment bioassay	4.8 m	Surficial layer of light brown flocculent material (~1 cm) over layer (~1 cm) of soft clay overlying hard clay.	No	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm. Sed. bioassay Art.sub./tissue residue
Transect Line T-6.5							
T-6.5 100m	Ponar samples Sediment - comp/3	7.0 m	Surficial layer of light brown flocculent material (~1 cm) overlying 5-7 cm of silt/clay. Wood waste (chips and bark) below surface layer. Oil below surface (beginning at -5 cm).	No	Yes	PAH & Nutrients	None
T-6.5 125m	Ponar samples Sediment - comp/3	6.3 m	Surficial layer of light brown flocculent material (~1 cm) overlying 5-7 cm of silt/clay. Some wood waste (chips and bark) below surface layer. Some surface oil (a few drops). Most oil below surface (beginning at -5 cm).	Yes	Yes	PAH & Nutrients	None

Transect & Distance	Sample type(s)	Water Depth	Description	Oil - Surface	Oil - sub-surface	Chemical Analysis	Biological Analysis
T-6.5 150m	Ponar samples Sediment - comp/3	7.0 m	Surficial layer of light brown flocculent material (~1 cm) overlying 5-7 cm of silt/clay. Some wood waste (chips and bark) below surface layer. Some surface oil (a few drops). Most oil below surface (beginning at -5 cm).	Yes	Yes	PAH & Nutrients	None
T-6.5 175m	Ponar samples Sediment - comp/3	6.7 m	Surficial layer of light brown flocculent material (~1 cm) overlying 5-7 cm of silt/clay. Some surface oil. Most oil below surface (beginning at -5 cm) with many large blobs/pockets in one grab.	Yes	Yes	PAH & Nutrients	None
T-6.5 200m	Ponar samples Sediment - comp/3	7.0 m	Surficial layer of light brown flocculent material (~2-4 mm) overlying clay layer (with some silt). Small amount of surface oil. Most oil below surface (beginning at -5 cm).	Yes	Yes	PAH & Nutrients	None
T-6.5 225m	Ponar samples Sediment - comp/3	6.7 m	Surficial layer of light brown flocculent material (~2-4 mm) overlying clay layer (with some silt). No surface oil. Some oil below surface (small specks/drops), beginning at -2.5 cm.	No	Yes	PAH & Nutrients	None
T-6.5 250m	Ponar samples Sediment - comp/3	7.4 m	Surficial layer of light brown flocculent material (~2-4 mm) overlying silt/clay layer of approx. 5 cm. Daeper layer of soft clay. No visible oil.	No	No	PAH & Nutrients	None
T-6.5 275m	Ponar samples Sediment - comp/3	7.4 m	Surficial layer of light brown flocculent material (~2-4 mm) overlying silt/clay layer of approx. 5 cm. Deeper layer of soft clay. No visible oil.	No	No	PAH & Nutrients	None
T-6.5 300m	Ponar samples Sediment - comp/3	6.7 m	Surficial layer of light brown flocculent material (~2-4 mm) overlying silt/clay layer of approx. 5 cm. Deeper layer of soft clay. No surface oil. A few small specks/drops in deeper layer (below 2.5 cm)	No	Yes	PAH & Nutrients	None
Transect Line T-7/9							

Transect & Distance	Sample type(s)	Water Depth	Description	Oil - Surface	Oil - sub-surface	Chemical Analysis	Biological Analysis
T-7/9 100m (150m) (Beak Stn G7)	Ponar samples Sediment - comp/3 Benthos - 3 reps Core samples - 14 cm Rep 1 - 27.5 Rep 2 - 25.5 Rep 3 - 28.4	8.1 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm over layer of soft clay. Some oil droplets on surface.	Yes	Yes	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
T-7/9 125m (185m)	Ponar samples Sediment - comp/3 Benthos - 3 reps	8.1 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm over layer of soft clay. Some oil droplets on surface and in subsurface layer.	Yes	Yes	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
T-7/9 150m (220m) (Beak Stn GG 7.5)	Ponar samples Sediment - comp/3 Benthos - 3 reps Core samples - 14 cm Rep 1 - 22 Rep 2 -13.6 Rep 3 -12.8	8.1 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm over layer of soft clay. Few oil droplets on surfece and in subsurface layer.	Yes	Yes	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
T-7/9 175m (255m)	Ponar samples Sediment - comp/3 Benthos - 3 reps	7.8 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm over layer of soft clay. No visible oil.	No	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
T-7/9 200m (290m) (Beak Stn H8)	Ponar samples Sediment - comp/3 Benthos - 3 reps Core samples - 20 cm Rep 1 - 20.4 Rep 2 - 18.5 Rep 3 - 14.7	8.5 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm over layer of soft clay. Some sand and gravel intermixed in clay leyer. No visible oil.	No	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
T-7/9 225m (325m)	Ponar samples Sediment - comp/3	8.5 m	Surficial layer of light brown flocculent fine-grained material approx. 0.5 cm over layer of soft clay. No visible oil.	No	No	PAH & Nutrients	None
T-7/9 250m (360m)	Ponar samples Sediment - comp/3 Benthos - 3 reps	8.5 m	Surficial layer of light brown flocculent fine-grained material approx. 0.5 cm over layer of soft clay. Some sand and gravel intermixed in clay layer. Small amount of wood waste in deeper layer in some samples. No visible oil.	No	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
T-7/9 275m (395m)	Ponar samples Sediment - comp/3	7.8 m	Surficial layer of light brown flocculent fine-grained material approx 1-2 mm hard-packed clay layer of 1-3 cm. No visible oil.	No	No	PAH & Nutrients	None

Transect & Distance	Sample type(s)	Water Depth	Description	Oil - Surface	Oil - sub-surface	Chemical Analysis	Biological Analysis
T-7/9 300m (430m) (Beak Stn I9)	Ponar samples Sediment - comp/3 Benthos - 3 reps Core samples Rep 1 - not obtained Rep 2 - not obtained Rep 3 - not obtained	8.5 m	Surficial layer of light brown flocculent fine-grained material approx 1-2 mm hard-packed clay layer of 1-3 cm. No visible oil. Core samples not obtained due to hard substrate.	No	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
			Transect Line T-FG				
T-FG 100m	Ponar samples Sediment - comp/3	6.7 m	Surficial layer of light brown flocculent fine-grained material (approx. 1 cm) over layer of soft clay with some silt (variegated grey-black layer). Some oil on surface and in deeper layers.	Yes	Yes	PAH & Nutrients	None
T-FG 125m	Ponar samples Sediment - comp/3	8.1 m	Surficial layer of light brown flocculent fine-grained material (approx. 1 cm) over layer of soft clay with some silt (variegated grey-black layer). No oil on surface. Oil drops/small blobs in deeper layers (2+ cm down).	No	Yes	PAH & Nutrients	None
T-FG 150m	Ponar samples Sediment - comp/3	8.1 m	Surficial layer of light brown flocculent fine-grained material (approx. 1 cm) over layer of soft clay with some silt (variegated grey-black layer). No oil on surface. Oil drops/small blobs in deeper layers (2+ cm down). One sample had large oil blob on surface.	No	Yes	PAH & Nutrients	None
T-FG 175m	Ponar samples Sediment - comp/3	8.5 m	Surficial layer of light brown flocculent fine-grained material over layer of soft clay with some silt (variegated grey-black layer). No oil on surface. Few small oil droplets in deeper layers (2+ cm down).	No	Yes	PAH & Nutrients	None
T-FG 200m	Ponar samples Sediment - comp/3	9.2 m	Surficial layer of light brown flocculent fine-grained material (1 cm) over layer of soft clay with some silt (variegated grey-black layer). No oil on surface. Few small oil droplets in deeper layers (2+ cm down).	No	Yes	PAH & Nutrients	None
T-FG 225m	Ponar samples Sediment - comp/3	8.5 m	Surficial layer of light brown flocculent fine-grained material (<1 cm) over softer clay layer, overlying hard clay layer. One sample had thin flocculent layer over hard reddish clay layer.	No	No	PAH & Nutrients	None

Transect & Distance	Sample type(s)	Water Depth	Description	Oil - Surface	Oil - sub-surface	Chemical Analysis	Biological Analysis
T-FG 250m	Ponar samples Sediment - comp/3	8.9 m	Surficial layer of light brown flocculent fine-grained material (<0.5 cm) over softer clay layer of approx. 1 cm, overlying hard clay layer.	No	No	PAH & Nutrients	None
T-FG 275m	Ponar samples Sediment - comp/3	8.5 m	Surficial layer of light brown flocculent fine-grained material (approx. 1-2 mm) over softer clay layer of approx. 1 cm, overlying hard clay layer.	No	No	PAH & Nutrients	None
T-FG 300m	Ponar samples Sediment - comp/3	9.6 m	Surficial layer of light brown flocculent fine-grained material (approx. 1-2 mm) over hard clay layer. Sand and gravel intermixed with clay.	No	No	PAH & Nutrients	None
Transect Line T-EF							
T-EF 100m	Ponar samples Sediment - comp/3 Benthos - 3 reps.	7.4 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm over approx. 5 cm of silt/clay muck overlying grey clay layer. Bark and wood waste intermixed with silt/clay. Oil droplets in sediment.	Yes	Yes	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
T-EF 125m	Ponar samples Sediment - comp/3 Benthos - 3 reps.	8.1 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm over approx. 5 cm of silt/clay muck overlying grey clay layer. Bark and wood waste intermixed with silt/clay. Oil droplets in sediment.	Yes	Yes	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
T-EF 150m	Ponar samples Sediment - comp/3 Benthos - 3 reps.	8.1 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm over approx. 5 cm of silt/clay muck overlying grey clay layer. Bark and wood waste intermixed with silt/clay. Oil droplets in deeper sediment.	No	Yes	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
T-EF 175m	Ponar samples Sediment - comp/3 Benthos - 3 reps.	8.5 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm overlying soft grey clay layer. Bark and wood waste intermixed with silt/clay. Some oil droplets in deeper sediment.	No	Yes	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
T-EF 200m	Ponar samples Sediment - comp/3 Benthos - 3 reps	8.1 m	Surficial layer of light brown flocculent fine-grained meterial approx. 1 cm overlying soft grey clay layer. Some bark and wood waste intermixed with silt/clay. No oil visible in sediment.	No	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.

Transect & Distance	Sample type(s)	Water Depth	Description	Oil - Surface	Oil - sub-surface	Chemical Analysis	Biological Analysis
T-EF 225m	Ponar samples Sediment - comp/3	8.1 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm overlying soft grey clay layer. No visible bark or wood waste. No oil visible in sediment.	No	No	PAH & Nutrients	None
T-EF 250m	Ponar samples Sediment - comp/3 Benthos - 3 reps.	9.2 m	Surficial layer of light brown flocculent fine-grained material approx. 2 mm overlying hard clay layer. No visible bark or wood waste. No oil visible in sediment.	No	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
T-EF 275m	Ponar samples Sediment - comp/3	9.6 m	Surficial layer of light brown flocculent fine-grained material approx. 2-5 mm overlying hard grey/pink clay layer. Some rock and gravel in clay layer. No visible oil, bark or wood waste.	No	No	PAH & Nutrients	None
T-EF 300m	Ponar samples Sediment - comp/3 Benthos - 3 reps.	8.5 m	Surficial layer of light brown flocculent fine-grained material approx. 2-5 mm overlying hard grey/pink clay layer. Some rock and gravel in clay layer. No visible oil, bark or wood waste.	No	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
Transect Line T-E							
T-E 100m (Beak Stn E7)	Core samples (3): 30 cm Rep 1 - 22.1 Rep 2 - 30.0 Rep 3 - 29.3	8 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm over epprox. 5 cm of silt/clay muck overlying grey clay layer.			PAH & Nutrients	None
T-E 150m (Beak Stn E7.5)	Core samples (3): 25 cm Rep 1 - 31 Rep 2 - 20.2 Rep 3 - 23.0	9 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm over approx. 5 cm of silt/clay muck overlying grey clay layer.			PAH & Nutrients	None
T-E 200m (Beak Stn E8)	Core samples (3): 20 cm Rep 1 - 18.8 Rep 2 - 24.5 Rep 3 - 30.1	9 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm overlying grey clay layer.			PAH & Nutrients	None
T-E 250m (Beak Stn E8.5)	Core samples (3): 37 cm Rep 1 - 25.7 Rep 2 - 22.7 Rep 3 - 19.8	9 m	Surficial layer of light brown flocculent fine-grained material approx. 2-3 mm overlying grey cley layer.			PAH & Nutrients	None
T-E 300m (Beak Stn E9)	Core samples (3): 25 cm Rep 1 - 25 Rep 2 - 16.6 Rep 3 - 24.8	9 m	Surficial layer of light brown flocculent fine-grained material approx. 2-3 mm overlying grey clay layer.			PAH & Nutrients	None
Transect Line T-C/D							

Transect & Distance	Sample type(s)	Water Depth	Description	Oil - Surface	Oil - sub-surface	Chemical Analysis	Biological Analysis
T-C/D 100m (150m)	Ponar samples Sediment - comp/3 Benthos - 3 reps.	7.8 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm over approx. 5 cm of silt/clay muck overlying grey clay layer. Bark and wood waste intermixed with silt/clay. Oil on and in sediment.	Yes	Yes	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
T-C/D 125m (185m)	Ponar samples Sediment - comp/3 Benthos - 3 reps.	8.1 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm over approx. 5 cm of silt/clay muck overlying grey clay layer. Bark and wood waste intermixed with silt/clay. Oil in sediment below surface.	No	Yes	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
T-C/D 150m (220m)	Ponar samples Sediment - comp/3 Benthos - 3 reps.	8.9 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm over approx. 5 cm of silt/clay muck overlying grey clay layer. Some bark and wood waste intermixed with silt/clay. Oil in sediment approx. 5 cm below surface. Few surface droplets.	Yes	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
T-C/D 175m (255m)	Ponar samples Sediment - comp/3 Benthos - 3 reps.	9.2 m	Surficial layer of light brown flocculent fine-grained material approx. 1 cm over approx. 2-5 cm of silt/clay muck overlying hard clay layer. Some bark and wood waste intermixed with silt/clay. No visible oil.	No	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
T-C/D 200m (290m)	Ponar samples Sediment - comp/3 Benthos - 3 reps.	9.2 m	Surficial layer of light brown silt/sand approx. 0.5 cm overlying hard reddish clay layer. Some gravel and rock in clay layer. No visible oil.	No	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.
Transect Line T-5S							
T-5S 75m	Ponar samples Sediment - comp/3	7.8 m	Surficial layer of light brown flocculent fine-grained material of approx. 2-3 mm. Subsurface silt/clay layer grey in colour. No visible oil or wood waste.	No	No	PAH & Nutrients	None
T-5S 100m	Ponar samples Sediment - comp/3	7.8 m	Surficial layer of light brown flocculent fine-grained material of approx. 2-3 mm. Subsurface silt/clay layer grey in colour. No visible oil or wood waste.	No	No	PAH & Nutrients	None
T-5S 125m	Ponar samples Sediment - comp/3	9 m	Surficial layer of light brown flocculent fine-grained material of approx. 2-3 mm. Subsurface silt/clay layer grey in colour. No visible oil or wood waste.	No	No	PAH & Nutrients	None

Transect & Distance	Sample type(s)	Water Depth	Description	Oil - Surface	Oil - sub-surface	Chemical Analysis	Biological Analysis
T-5S 150m	Ponar samples Sediment - comp/3		Sample not obtained - this station would have been located on the CN ore dock.			PAH & Nutrients	None
			Controls				
C-1: Control ne. of site by breakwater n. of Main Gap Lighthouse	Ponar samples Sediment - comp/3 Benthos - 3 reps Sediment Bioassay	8.1 m	Surficial layer of light brown flocculent material epprox 5 mm thick overlying grey silt/clay muck.	No	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm. Sed. bioassay
C-2: Control se. of site by breakwater just n. of Inner City Gap.	Ponar samples Sediment - comp/3 Benthos - 3 reps	6.3 m	Surficial leyer of light brown flocculent material approx 5 mm thick overlying grey silt/clay muck approx. 5-7 cm with mainly clay deeper layer.	No	No	Metals, nutrients, PCB/oc/cp, cb, PAH, diox.	Benthic comm.

Table 2: Description of Sediment Sampling Sites. Northern Wood Preservers, Thunder Bay. September 1995

Location	Sample Type	Water Depth	Description	Chemical Analysis	Biological Analysis
Transect 4.5					
Transect 4.5 - 25m	Sediment samples: composite of 3 Ponar grabs	3.7 m	Little natural sediment (small amounts fine sediment and sand). Primarily wood waste. Very little visible oil.	TOC PAH	None
Transect 4.5 - 50m	Sediment samples: composite of 3 Ponar grabs	4.8 m	Little natural sediment (not enough for sediment samples). Substrate primarily wood waste (bark, chips, etc) with no visible oil.	TOC PAH	None
Transect 4.5 - 75m	Sediment samples: composite of 3 Ponar grabs	3.3 m	Light brown surface layer up to 1 cm thick overlying mid-grey clay layer. Some surface vegetation. No visible oil	TOC PAH	None
Transect 4.5 - 100m	Sediment samples: composite of 3 Ponar grabs	3.5 m	Light brown surfece layer up to 1 cm thick overlying mid-grey clay layer. Some surface vegetation. No visible oil	TOC PAH	None
Transect 5					
Transect 5 - 25m	Sediment samples: composite of 3 Ponar grabs	5.6 m	Black sediment consisting of over 50% liquid creosote.	None	None
Transect 5 - 50m	Sediment samples: composite of 3 Ponar grabs	4.8 m	Black sediment with significant quantity (>25%) liquid creosote.	TOC PAH	None
Transect 5 - 75m	Sediment samples: composite of 3 Ponar grabs	4.1 m	Light brown surface layer (silt) approx. 1-2 mm overlying mid-grey clay layer. Layer of wood waste et bottom of samples (approx. 8 cm down). Few small drops of oil in sample.	TOC PAH	None
Transect 5 - 100m	Sediment samples: composite of 3 Ponar grabs	4.1 m	Light brown surface layer (silt) approx. 1-2 mm overlying mid-grey clay layer. Some surface vegetation. Few small droplets of oil on surface.	TOC PAH	None
Transect 5.5					
Transect 5.5 - 25m	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates Sediment Bioassay - 15 L	5.2 m	Dark-grey/black surface layer, apparently lacking the fine light silt layer. Drops and bubbles of surface and subsurface oil. Strong odour.	TOC PAH Dioxins & Furans	Benthic community Sediment bioassay

Location	Sample Type	Water Depth	Description	Chemical Analysis	Biological Analysis
Transect 5.5 - 50m	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates Sediment Bioassay - 15 L	4.4 m	Dark surface layer, apparently lacking fine silt layer. A few drops of oil on surface. Larger drops in sample.	TOC PAH Dioxins & Furans	Benthic community Sediment bioassay
Transect 5.5 - 75m	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates Sediment Bioassay - 15 L	3.3 m	Light brown surface layer overlying mid-grey clay layer. Surfece vegetation as well as detritus deeper in sample. Little surface oil. Larger drops in deeper sediment layer.	TOC PAH Dioxins & Furens	Benthic community Sediment bioassay
Transect 5.5 - 100m	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates Sediment Bioassay - 15 L	3.7 m	Light brown surface layer overlying mid-grey clay layer. Some surfece vegetetion. Few spots of oil on surface.	TOC PAH Dioxins & Furans	Benthic community
Transect 6					
Transect 6 - 5 m	Sediment samples - visual inspection only.	5.6 m	Grey-black clay layer, fine surface layer apparently lacking. Significant amounts of subsurface oil. Oil blobs on surface.	None	None
Transect 6 - 25m	Sediment samples - composite of 3 Ponar grabs	5.9 m	Grey-black.clay layer, fine surface layer apparently lacking. Significant amounts of subsurface oil. Oil blobs on surface.	TOC PAH	None
Transect 6 - 50m	Sediment samples - composite of 3 Ponar grabs	5.6 m	Grey-black surface layer epparently lacking fine sediment layer. Surface and subsurface oil present as drops and small blobs.	TOC PAH	None
Transect 6 - 75m	Sediment samples - composite of 3 Ponar grabs	6.0 m	Light brown surface layer approx. 5mm overlying firm grey clay layer. Some surface oil as small blobs. Subsurface oil.	TOC PAH	None
Transect 6 - 100m	Sediment samples - composite of 3 Ponar grabs	6.7 m	Light brown surface layer approx. 5mm overlying firm grey clay layer. No visible surface oil. Subsurface oil present as drops.	TOC PAH	None
Transect 7/9					
Transect 7/9 - 35m	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates	7.4 m	Black surface layer apparently lacking fine silt layer. Oil present on both surface and subsurface as small blobs.	TOC PAH	Benthic community
Transect 7/9 - 70m	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates	6.7 m	Light brown surface silt layer over grey clay. Some globules of oil on surface. Subsurface oil as small blobs.	TOC PAH	Benthic community

Location	Sample Type	Water Depth	Description	Chemical Analysis	Biological Analysis
Transect 7/9 - 105m	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates	6.7 m	Light brown surface layer overlying grey clay leyer. Small drops of oil on surface. Larger drops and blobs in subsurface layer.	TOC PAH	Benthic community
Transect 7/9 - 140m	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates	7.8 m	Light brown surface layer overlying grey clay leyer. Few small drops of oil on surface and in subsurface leyer.	TOC PAH	Benthic community
Transect EF					
Transect EF - 25m	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates Sediment Bioassay - 15 L	7.4 m	Dark grey/black sediment. Significant amount of oil on surface and in subsurfece layers. No benthic samples obtained due to high oil content.	TOC PAH Dioxins & Furans	Benthic community Sediment bioassay
Transect EF - 50m	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates Sediment Bioassay - 15 L	7.4 m	Thin light brown surface layer over grey clay. Drops and small blobs of surfece and subsurfece oil throughout samples.	TOC PAH Dioxins & Furans	Benthic community Sediment bioassay
Transect EF - 75m	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates Sediment Bioassay - 15 L	7.8 m	Light brown surface layer approx. 5 mm thick overlying grey clay layer. No surface oil, subsurfece oil within 2.5 cm of surface.	TOC PAH Dioxins & Furans	Benthic community Sediment bioassay
Transect DE					
Transect DE - 5m	Sediment samples - visual observation only		Sediment a mixture of fine silt, clay and wood chips/waste. Variable emounts of oil in subsurface layer (present in some samples, virtually absent in others). Little oil on surface.	None	None
Transect DE - 25m	Sediment samples - composite of 3 Ponar grabs	7.4 m	Sediment a mixture of fine silt, clay and wood chips/waste. Variable emounts of oil in subsurface layer (present in some samples, virtually absent in others). Little oil on surface.	TOC PAH	None
Transect DE - 50m	Sediment samples - composite of 3 Ponar grabs	7.8 m	Thin light brown surface layer overlying grey clay layer. Subsurface oil, some surface oil.	TOC PAH	None
Transect DE - 75m	Sediment samples - composite of 3 Ponar grabs	8.1 m	Thin light brown surface layer overlying grey clay layer. Subsurface oil, little surface oil (few small droplets).	TOC PAH	None
Transect DE - 100m	Sediment samples - composite of 3 Ponar grabs	8.5 m	Thin light brown layer overlying grey clay layer. Some subsurface oil, no surface oil.	TOC PAH	None

Location	Sample Type	Water Depth	Description	Chemical Analysis	Biological Analysis
Transect E					
Transect E - 5m	Sediment samples - visual inspection only.	6.7 m	Thin brown surface layer overlying grey clay layer. Some drops and small blobs of surface and subsurface oil.	None	None
Transect E - 25m	Sediment samples - composite of 3 Ponar grabs	4.4 m	Thin light brown surface layer over grey clay. Drops and small blobs of surface and subsurface oil throughout samples.	TOC PAH	None
Transect E - 50m	Sediment samples - composite of 3 Ponar grabs	6.7 m	Thin light brown surface layer over grey clay. Drops and small blobs of surface and subsurface oil.	TOC PAH	None
Transect D					
Transect D - 5 m	Sediment samples - visual inspection only	6.3 m	Sediment primarily wood waste (chips) with little fine sediment. Few small dots of oil in sediment.	None	None
Transect D - 25m	Sediment samples - composite of 3 Ponar grabs	6.7 m	Light brown surface layer overlying clay. Large amount of wood waste (chips) below surface layer. Subsurface oil as small drops in wood waste layer. No surface oil.	TOC PAH	None
Transect D - 50m	Sediment samples - composite of 3 Ponar grabs	6.7 m	Light brown surface layer overlying clay layer with large amount of wood waste (chips) below surface. No surface oil, some subsurface oil as small bubbles.	TOC PAH	None
Transect D - 75m	Sediment samples - composite of 3 Ponar grabs	7.8 m	Light brown surface layer overlying clay. Algal layer on sediment surface. Some surface and subsurface oil present as drops.	TOC PAH	None
Transect D - 100m	Sediment samples - composite of 3 Ponar grabs	8.1 m	Light brown surface layer overlying clay. No oil visible on surface or in subsurface layers.	TOC PAH	None
Transect 6/7					
Transect 6/7 - 25m (35m)	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates	7.4 m	Light brown surface layer overlying grey clay layer. Few small drops of oil on surface. Subsurface oil as drops and a few small blobs.	TOC PAH	Benthic community
Transect 6/7 - 50 (70m)	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates	8.1 m	Light brown surface layer overlying grey clay layer. Few small drops of oil on surface. Subsurface oil as drops and a few small blobs.	TOC PAH	Benthic community

Location	Sample Type	Water Depth	Description	Chemical Analysis	Biological Analysis
Transect 6/7 - 75m (105m)	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates	7.8 m	Light brown surface layer (1-2 mm) over grey clay layer. Few small drops of oil in subsurface. No surface oil.	TOC PAH	Benthic community
Transect 6/7 - 100m (140m)	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates	8.1 m	Light brown surface layer overlying grey clay layer. Few small drops of oil on surface. Subsurface oil as drops and a few small blobs.	TOC PAH	Benthic community
Transect 5.5S					
Transect 5.5S - 25m	Sediment samples - composite of 3 Ponar grabs	2.6 m	Sediment mainly wood waste (chips and fibre) with small amount of silt and sand. No visible oil.	TOC PAH	None
Transect 5.5S - 50m	Sediment samples - composite of 3 Ponar grabs	4.4 m	Sediment mainly wood waste (bark, chips and fibre) with small amount of silt and sand. No visible oil. Oil sheen left on water.	TOC PAH	None
Control					
Control C-1	Sediment samples - composite of 3 Ponar grabs Benthos - 3 replicates Sediment Bioassay - 15 L	9.3 m	Light brown surface layer (approx. 5 mm) overlying grey clay.	TOC PAH Dioxins & Furans	Benthic community Sediment bioassay

Table 3: PAH Concentrations in Surficial Sediment Samples. Northern Wood Preservers - Thunder Bay. Phase I (July 1995) and Phase II (September 1995). All concentrations ng/g (ppb) dry weight.

	Phase	Naphth-alene	Acenaph-thylene	Acenaph-thene	Fluorene	Phenan-threne	Anthra-cene	Fluoran-thene	Pyrene	Benzo[a] anthracene
Control 1	I	120	20<W	20<W	20<W	220	40<T	320	280	120
Control 2	I	140	20<W	20<W	20<W	220	40<T	320	260	120
Control 1	II	20<W	20<W	40<T	420	240	60<T	440	340	140
Transect 4.5										
T 4.5-25m	II	3200	1500	3200	4900	21000	8600	39000	28000	17000
T 4.5-75m	II	2200	420	480	640	3000	1100	5700	4200	2300
T 4.5-100m	II	2800	520	540	800	3800	1500	8300	6200	3500
Transect 5										
T 5-50m	II	3300000	34000	1300000	1200000	3800000	430000	2200000	1500000	550000
T 5-75m	II	4000	400	1000	980	3400	840	4500	3400	1900
T 5-100m	II	1800	320	840	860	2800	660	3500	2600	1300
Transect 5.5										
T 5.5-25m	II	14000	1000	9000	10000	42000	7800	45000	31000	13000
T 5.5-50m	II	1500	400	760	900	3900	1400	9000	6700	3600
T 5.5-75m	II	3200	760	7000	11000	63000	7600	73000	52000	18000
T 5.5-100m	II	2600	400	1400	1900	6100	1800	19000	14000	7400
T 5.5-100m	I	2900	260	820	1100	2900	1000	7700	6100	3400
T 5.5-125m	I	2400	300	1100	1700	4900	1500	8400	6300	4100
T 5.5-150m	I	1900	200	680	980	1900	700	4900	3600	2100
T 5.5-175m	I	840	140	260	260	1000	360	1800	1300	780
T 5.5-200m	I	680	120	240	260	1000	340	1800	1300	680
T 5.5-250m	I	340	80<T	160	200	820	260	1200	900	460
T 5.5-300m	I	240	80<T	60<T	100	620	180	960	700	360
T 5.5-350m	I	340	80<T	80<T	120	720	220	1100	800	440
T 5.5-400m	I	280	80<T	140	180	1200	280	1600	1200	600
T 5.5-500m	I	240	80<T	40<T	60<T	560	140	1000	840	400
Transect 6										
T 6-25m	II	13000	860	13000	15000	68000	9600	63000	44000	18000
T 6-50m	II	5200	520	5500	6200	21000	3800	25000	18000	8100
T 6-75m	II	1200	340	1500	2000	7000	1800	16000	11000	5000
T 6-100m	II	2100	340	940	1600	6900	1900	18000	13000	6000
Transect 6.5										
T 6.5-100m	I	3900	220	1400	2000	8900	15000	12000	8100	3500
T 6.5-125m	I	3300	160	1200	1400	6300	1000	8500	6000	2700
T 6.5-150m	I	600	120	760	720	2800	640	3900	2700	1300
T 6.5-175m	I	700	120	240	300	1300	460	2200	1600	900
T 6.5-200m	I	440	120	400	580	3400	540	3300	2300	980
T 6.5-225m	I	420	100	160	160	840	260	1200	840	520
T 6.5-250m	I	360	100	100	120	620	200	860	680	400
T 6.5-275m	I	260	80<T	180	140	700	200	980	720	440
T 6.5-300m	I	160	60<T	40<T	80<T	500	140	760	560	340
Transect 7/9										
T 7/9-35m	II	24000	1000	17000	18000	78000	9800	67000	47000	19000
T 7/9-70m	II	8900	600	8300	9100	37000	4400	32000	22000	8600
T 7/9-105m	II	5200	400	3400	4500	15000	2700	16000	11000	6100
T 7/9-150m	II	700	200	480	640	3300	1300	6400	4700	2500
T 7/9-150m	I	1200	200	1400	1900	6700	2100	9600	7100	3500
T 7/9-185m	I	960	160	1800	2600	8900	3000	9900	7100	3700
T 7/9-220m	I	780	160	700	900	3700	2000	6300	4500	2700
T 7/9-255m	I	720	120	480	520	2300	1000	3800	2700	1200
T 7/9-290m	I	540	80<T	320	380	1400	400	1800	1200	620
T 7/9-325m	I	300	40<T	160	200	740	200	820	580	340
T 7/9-360m	I	340	40<T	220	280	1400	380	1800	1200	460
T 7/9-395m	I	120	20<W	20<W	20<W	60<T	20<W	40<T	40<T	20<W

Table 3: cont'd

	Phase	Naphth-alene	Acenaph-thylene	Acenaph-thene	Fluorene	Phenan-threne	Anthra-cene	Fluoran-thene	Pyrene	Benzo[e] enthracene
Transect FG										
T FG-100m	I	2200	200	900	1100	5700	1400	9300	6600	2800
T FG-125m	I	1600	280	3800	5100	23000	3700	19000	13000	4700
T FG-150m	I	1800	280	3600	4800	25000	6100	23000	15000	6000
T FG-175m	I	1400	180	1100	1300	6000	1400	7600	5300	2400
T FG-200m	I	740	100	320	300	1300	380	2000	1400	660
T FG-225m	I	660	60<T	340	440	1700	520	2500	1700	800
T FG-250m	I	420	40<T	180	180	740	200	840	560	260
T FG-275m	I	580	100	300	520	2000	640	3500	2300	1600
T FG-300m	I	300	20<W	120	120	1300	380	2200	1600	740
Transect EF										
T EF-25m	II	130000	3600	120000	120000	450000	54000	290000	200000	68000
T EF-50m	II	24000	920	22000	24000	99000	11000	70000	48000	17000
T EF-75m	II	2200	320	2100	2500	10000	2500	12000	8500	4500
T EF-100m	I	1100	160	440	540	3300	860	6100	4300	1800
T EF-125m	I	2700	200	1200	1400	6200	1500	8900	6200	2700
T EF-150m	I	1900	120	620	640	2800	680	4400	3000	1300
T EF-175m	I	2100	160	1600	1800	9000	1300	8900	6100	2200
T EF-200m	I	1600	120	460	360	1700	380	2200	1500	660
T EF-225m	I	1400	120	380	380	1400	420	4000	2900	1100
T EF-250m	I	1500	100	440	560	1300	460	3000	2100	1200
T EF-275m	I	340	20<W	60<T	60<T	340	100	440	320	140
T EF-300m	I	680	40<T	100	100	540	140	740	580	240
Transect E										
T E-25m	II	24000	340	4700	4300	13000	2700	14000	9600	5100
T E-50m	II	3900	320	1900	1700	6400	1500	8500	6300	2900
Transect DE										
T DE-25m	II	6600	240	2100	1700	5200	1200	6800	4900	2200
T DE-50m	II	1500	220	680	780	4100	1000	7000	5000	2500
T DE-75m	II	2900	200	1100	1100	3900	1100	6400	4600	2200
T DE-100m	II	960	160	600	760	3800	920	5800	4100	1800
Transect D										
T D-25m	II	3600	200	940	960	3600	980	4900	3500	1700
T D-50m	II	940	160	480	520	2400	640	4400	3200	1600
T D-75m	II	3800	240	2400	1600	4800	1000	6200	4500	1800
T D-100m	II	1300	180	640	680	3000	7900	5100	3700	1800
Transect CD										
T CD-150m	I	1700	160	820	880	4300	1000	6500	4600	1800
T CD-185m	I	1600	120	660	840	3200	780	4900	3400	1600
T CD-220m	I	1300	120	520	660	2100	460	2900	2000	800
T CD-255m	I	540	60<T	160	240	1000	240	1300	960	500
T CD-290m	I	600	20<W	100	100	420	100	520	380	160
Transect 6/7										
T 6/7-35m	II	2700	160	340	300	1300	420	2900	2100	1400
T 6/7-70m	II	1100	140	440	420	1500	440	2400	1700	920
T 6/7-105m	II	940	140	240	280	1100	380	2200	1600	780
T 6/7-140m	II	1500	120	300	280	940	300	1500	1100	500
Transect 5.5s										
T 5.5s-25m	II	11000	2500	2400	5600	28000	7000	31000	22000	9700
T 5.5s-50m	II	2700	1000	1000	3000	13000	3000	14000	10000	4900
T 5.5s-75m	I	800	140	320	460	2000	940	4200	3100	1400
T 5.5s-100m	I	720	160	240	300	1100	460	2300	1800	720
T 5.5s-125m	I	900	200	340	460	1700	780	3700	2700	1400

<T = trace amount <W = below detection limit

Table 3: cont'd.

	Phese	Chrysene	Benzo[b] fluoran-thene	Benzo[k] fluoran-thene	Benzo[e] pyrene	Benzo [g,h,i] perylene	Dibenzo [a,h]an-thracene	Indeno [123-cd] pyrene	Totel PAH	TOC mg/g
Control 1	I	160	300	140	160	120<T	40<W	120<T	2200	
Control 2	I	180	240	160	160	120<T	40<W	120<T	2180	
Control 1	II	180	220	140	120<T	120<T	40<W	120<T	2660	27
Transect 4.5										
T 4.5-25m	II	19000	26000	14000	14000	12000	3800	12000	227200	98
T 4.5-75m	II	3100	5100	2800	2800	2600	560	2600	39600	92
T 4.5-100m	II	4500	5800	3100	3500	2700	600	2700	50860	120
Transect 5										
T 5-50m	II	420000	500000	290000	350000	200000	43000	210000	16327000	210
T 5-75m	II	2200	4500	2600	2900	3100	600	3100	39420	38
T 5-100m	II	1700	3700	1800	2100	2200	480	2200	28860	44
Transect 5.5										
T 5.5-25m	II	12000	18000	8300	12000	8100	2600	8400	242200	84
T 5.5-50m	II	3900	6900	4000	4900	4200	960	4200	57220	57
T 5.5-75m	II	15000	21000	11000	14000	8800	3000	8800	317160	29
T 5.5-100m	II	6700	9900	5900	7300	5000	1200	5000	95600	30
T 5.5-100m	I	3200	5200	3400	4200	3400	960	4000	50540	
T 5.5-125m	I	3900	4700	3000	3600	3700	1000	4600	55200	
T 5.5-150m	I	4400	2000	3000	3000	2000	600	2900	34860	
T 5.5-175m	I	940	2100	1200	1400	1200	240	1600	15420	
T 5.5-200m	I	800	1700	960	1100	1100	240	1300	13620	
T 5.5-250m	I	560	1200	700	760	760	160	960	9520	
T 5.5-300m	I	480	920	540	600	600	120<T	840	7400	
T 5.5-350m	I	560	1100	660	640	680	200	1000	8740	
T 5.5-400m	I	680	1100	680	760	640	200	1000	10620	
T 5.5-500m	I	520	980	580	600	600	160<T	920	7720	
Transect 6										
T 6-25m	II	16000	19000	12000	13000	9200	2600	9600	325860	74
T 6-50m	II	7000	9600	5800	6800	5000	1600	5000	134120	46
T 6-75m	II	5600	5900	4900	6200	4400	1000	4500	78340	30
T 6-100m	II	5900	6400	4900	5100	4300	1000	4400	82780	25
Transect 6.5										
T 6.5-100m	I	2500	5000	2400	3500	2500	3700	2300	76920	
T 6.5-125m	I	1800	3900	1900	2800	2100	320	1800	45180	
T 6.5-150m	I	1100	2100	1200	1500	1300	200	1100	22040	
T 6.5-175m	I	900	1900	1000	1200	1000	160<T	880	14860	
T 6.5-200m	I	880	1800	1000	1300	1000	160<T	960	19160	
T 6.5-225m	I	580	1300	740	880	840	120<T	600	9560	
T 6.5-250m	I	460	1100	600	720	640	80<T	560	7600	
T 6.5-275m	I	480	1300	540	720	640	80<T	560	8020	
T 6.5-300m	I	380	920	540	560	560	80<T	480	6160	
Transect 7/9										
T 7/9-35m	II	16000	21000	11000	14000	9400	3200	9500	364900	66
T 7/9-70m	II	7100	10000	5400	7100	4800	1700	1200	168200	35
T 7/9-105m	II	5100	6400	4400	5800	4100	1000	4100	95200	27
T 7/9-150m	II	3000	4000	2200	2800	2100	520	2100	36940	26
T 7/9-150m	I	3000	3700	2100	3700	2200	600	2800	51800	
T 7/9-185m	I	3200	2800	1800	3400	2000	560	3000	54880	
T 7/9-220m	I	2500	2100	1800	2700	1700	400	2100	35040	
T 7/9-255m	I	1400	1600	1400	1400	960	280	1100	20980	
T 7/9-290m	I	700	1300	700	840	560	120<T	800	11760	
T 7/9-325m	I	460	580	380	440	360	80<T	320	6000	
T 7/9-360m	I	500	700	480	520	360	880	440	10000	
T 7/9-395m	I	20<W	20<W	20<W	40<W	40<W	40<W	40<W	580	
Transect FG										
T FG-100m	I	2200	4300	2300	3300	2200	400	1900	46800	
T FG-125m	I	5300	5800	4000	4600	2700	680	2300	99560	
T FG-150m	I	8100	7700	4500	5900	3200	680	2800	118460	
T FG-175m	I	2100	3600	1800	2400	1800	320	1500	40200	
T FG-200m	I	660	1200	660	760	560	80<T	440	11560	
T FG-225m	I	780	1200	640	840	520	80<T	440	13220	
T FG-250m	I	280	420	220	280	200	40<W	120<T	4980	

Table 3: cont'd

	Phase	Chrysene	Benzo[b] fluoran-thene	Benzo[k] fluoran-thene	Benzo[a] pyrene	Benzo [g,h,i] perylene	Dibenzo [a,h]an-thracene	Indeno [123-cd] pyrene	TotalPAH	
T FG-275m	I	1600	3000	1200	2000	1200	200	1000	21740	
T FG-300m	I	680	840	420	640	400	40<W	360	10160	
Transect EF										
T EF-25m	II	52000	65000	35000	46000	28000	7100<T	29000	1697700	73
T EF-50m	II	14000	19000	9800	12000	8400	2400	8400	389920	49
T EF-75m	II	4400	7000	6400	4100	3100	760	3100	73480	41
T EF-100m	I	1700	3900	1800	2400	1700	400	2300	32800	
T EF-125m	I	2400	4700	2200	3000	2000	480	2400	48180	
T EF-150m	I	1300	1900	1200	1400	1000	160<T	1200	23620	
T EF-175m	I	1800	3000	1500	1800	1200	320	1500	44280	
T EF-200m	I	740	1000	660	760	520	80<T	520	13260	
T EF-225m	I	1000	1500	840	960	720	120<T	720	17960	
T EF-250m	I	1300	1600	920	1200	720	120<T	960	17480	
T EF-275m	I	180	240	140	160<T	120<T	40<W	120<T	2820	
T EF-300m	I	300	380	220	240	160<T	40<W	160<T	4660	
Transect E										
T E-25m	II	4800	5300	4300	4500	3400	720	3400	104160	54
T E-50m	II	3200	4800	2200	2800	2300	480	2300	51500	40
Transect DE										
T DE-25m	II	2400	3700	2000	2100	1700	360	1600	44800	52
T DE-50m	II	2800	3900	1500	1800	1400	360	13000	47540	48
T DE-75m	II	2400	3300	1800	2000	1600	360	1600	36560	33
T DE-100m	II	1900	2800	1600	1600	1300	280	1200	29580	31
Transect D										
T D-25m	II	2000	3100	1700	1900	1500	320	1400	32300	57
T D-50m	II	1800	2600	1100	1400	1100	280	1000	23620	36
T D-75m	II	1900	2700	1600	1600	1200	240	1100	36680	28
T D-100m	II	2000	2400	1200	1500	1200	3000	1200	36800	27
Transect CD										
T CD-150m	I	1600	2500	1300	1500	1000	200	1100	30960	
T CD-185m	I	1400	2000	1000	1300	880	160<T	640	24480	
T CD-220m	I	740	1300	700	680	400	80<T	320	15080	
T CD-255m	I	500	780	420	480	280	40<W	320	7820	
T CD-290m	I	120	180	100	120<T	40<W	40<W	40<W	3040	
Transect 6/7										
T 6/7-35m	II	1700	2900	1000	1200	1000	240	960	20620	39
T 6/7-70m	II	1100	1700	1100	1100	880	200	840	15980	29
T 6/7-105m	II	1000	1600	940	960	800	160	760	13880	22
T 6/7-140m	II	680	980	620	680	560	160<T	480	10700	17
Transect 5.5s										
T 5.5s-25m	II	10000	11000	6700	8800	5800	1600	6100	169200	76
T 5.5s-50m	II	5200	5700	2900	4700	3500	760	3500	78860	83
T 5.5s-75m	I	1400	2300	1500	1400	1200	280	1200	22640	
T 5.5s-100m	I	940	1600	960	960	960	200	880	14300	
T 5.5s-125m	I	1600	2800	1700	1700	1600	360	1700	23640	

<T = trace amount <W = below detection limit

Table 4: PAH Concentrations in Sediment Core Samples. Phase I (July 1995). Northern Wood Preservers, Thunder Bay.
All concentretions in ng/g dry weight.

	Naphth-alene	Acenaph-thylene	Acenaph-thene	Fluorene	Phenan-threne	Anthra-cene	Fluoran-thene	Pyrene	Benzo[a] anthracene
Transect 5									
T5.5-100m	2400	120	2000	2400	8000	1900	7300	5100	3600
T5.5-150m	1800	100	760	980	5100	1400	7800	5600	2400
T5.5-200m	400	40<T	260	320	1800	420	3400	2500	1000
T5.5-250m	60<T	20<W	60<T	80<T	660	220	1600	1100	640
T5.5-300m	20<W	20<W	20<W	40<T	300	80	620	460	260
T5.5-350m	280	100	120	240	1400	420	2800	2100	1200
T5.5-400m	340	80<T	160	320	2100	580	2900	2200	1100
T5.5-500m	4200	60<T	480	500	2000	540	3000	2400	1300
Transect 7/9									
T7/9c-150m	2100	400	7600	9800	48000	8500	37000	25000	9000
T7/9c-220m	600	100	1300	1800	7000	1400	6000	4000	2200
T7/9c-290m	640	40<T	540	520	2200	480	2300	1600	740
Transect E									
TE-100m	1800	340	5900	7000	36000	6300	30000	21000	8000
TE-150m	760	80<T	1200	1500	6800	2800	7900	5600	2500
TE-200m	200	20<W	320	480	2300	460	2400	1600	660
TE-250m	40<T	20<W	40<T	60<T	260	40<T	240	180	60<T
TE-300m	300	20<W	60<T	100	680	200	880	660	280

	Chrysene	Benzo[b] fluoran-thene	Benzo[k] fluoran-thene	Benzo[a] pyrene	Benzo [g,h,i] perylene	Dibenzo [a,h]an-thracene	Indeno [123-cd] pyrene	TotalPAH
Transect 5								
T5.5-100m	2900	4000	2500	3100	2000	480	2400	50200
T5.5-150m	2500	3100	1700	2000	1400	360	1600	38600
T5.5-200m	1100	1100	740	800	560	160	640	15240
T5.5-250m	780	820	580	600	440	80<T	440	8180
T5.5-300m	340	440	240	280	200	40<W	200	3560
T5.5-350m	1500	1600	1200	1200	920	200	960	16240
T5.5-400m	1300	1500	1100	1200	880	160<T	960	16880
T5.5-500m	1700	1800	1200	1200	840	160<T	880	22260
Transect 7/9								
T7/9c-150m	9100	8000	6000	7600	4400	1300	4300	188100
T7/9c-220m	2000	2000	1600	1700	1100	240	1200	34240
T7/9c-290m	760	860	580	600	360	80<T	360	12660
Transect E								
TE-100m	8700	9400	5800	7000	4100	1200	4200	156740
TE-150m	3500	2500	1800	2100	1200	80<T	1300	41620
TE-200m	740	700	480	560	320	80<T	320	11640
TE-250m	80<T	40<T	40<W	40<W	40<W	40<W	40<W	1260
TE-300m	340	240	160	240	120<T	40<W	120<T	4440

Table 5: PAH Concentrations in Sediment Bioassay Samples. Phase I (July 1995). Northern Wood Preservers, Thunder Bay.
All concentrations in ng/g dry weight.

	Naphth-alene	Acenaph-thylene	Acenaph-thene	Fluorene	Phenan-threne	Anthra-cene	Fluoran-thene	Pyrene	Benzo[a] anthracene
T5.5-100m	5300	520	6300	7000	31000	6700	42000	28000	15000
T5.5-125m	5000	700	7300	8800	41000	8300	52000	34000	19000
T5.5-150m	3000	480	4500	5800	28000	6100	34000	22000	13000
T5.5-175m	1300	180	480	860	2200	660	4700	3400	2100
T5.5-200m	840	140	320	360	1500	440	2700	2000	1100
T5.5-250m	520	120	240	320	1300	480	2400	1800	1100
T5.5-300m	440	80<T	160	180	940	260	1500	1200	620
T5.5-350m	280	60<T	80<T	120	760	180	1300	1000	560
T5.5-400m	460	60<T	220	280	1800	440	2300	1700	860
T5.5-500m	n.a.	n.a.	n.a.	n.a	n.a.	n.a.	n.a.	n.a.	n.a.

	Chrysene	Benzo[b] fluoran-thene	Benzo[k] fluoran-thene	Benzo[a] pyrene	Benzo [g,h,i] perylene	Dibenzo [a,h]an-thracene	Indeno [123-cd] pyrene	TotalPAH
T5.5-100m	13000	19000	7900	12000	7700	2000	10000	213420
T5.5-125m	16000	19000	9400	14000	8600	2700	13000	258800
T5.5-150m	12000	14000	7700	10000	6600	1600	8200	176980
T5.5-175m	1700	4400	1500	2400	1700	360	1700	29640
T5.5-200m	1100	2200	1200	1400	1200	200	960	17660
T5.5-250m	1100	2300	980	1400	1200	160<T	1000	16420
T5.5-300m	720	1300	600	760	720	120<T	560	10160
T5.5-350m	560	920	540	640	520	80<T	600	8200
T5.5-400m	900	1400	680	920	760	120<T	640	13540
T5.5-500m	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	

<W - below detection limit <T - trace amount

Table 6: PCB and Organochlorine Pesticide Concentrations in Surficial Sediment. Phase I (July 1995). Northern Wood Preservers, Thunder Bay. All values in ng/g dry weight.

	PCB, totel	HCB	Heptachlor	Aldrin	pp-DDE	Mirex	a-BHC	b-BHC	g-BHC	a-Chlor-dane	g-Chlor-dane	Oxychlor-dane
Control 1	20<W	1<W	1<W	1<W	1<W	5<W	1<W	14	1<W	2<W	2<W	2<W
Control 2	20<W	1<W	1<W	1<W	1<W	5<W	1<W	18	1<W	2<W	2<W	2<W
Transect 5.5												
T 5.5-100m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T 5.5-125m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T 5.5-150m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	31	1<W	2<W	2<W	2<W
T 5.5-175m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	23	1<W	2<W	2<W	2<W
T 5.5-200m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	23	1<W	2<W	2<W	2<W
T 5.5-250m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T 5.5-300m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	15	1<W	2<W	2<W	2<W
T 5.5-350m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	18	1<W	2<W	2<W	2<W
T 5.5-400m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	24	1<W	2<W	2<W	2<W
T 5.5-500m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	9	1<W	2<W	2<W	2<W
Transect 7/9												
T 7/9-150m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T 7/9-185m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T 7/9-220m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T 7/9-255m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	8	1<W	2<W	2<W	2<W
T 7/9-290m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	12	1<W	2<W	2<W	2<W
T 7/9-360m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	16	1<W	2<W	2<W	2<W
Transect EF												
T EF-100m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T EF-125m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T EF-150m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T EF-175m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T EF-200m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T EF-250m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T EF-300m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
Transect CD												
T CD-150m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T CD-185m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T CD-220m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T CD-255m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W
T CD-290m	20<W	1<W	1<W	1<W	1<W	5<W	1<W	1<W	1<W	2<W	2<W	2<W

<W - below detection limit <T - trace amount

Table 6: cont'd.

	op-DDT	pp-DDD	pp-DDT	Methoxychlor		Haptachlor epoxide	Endosul-phan-I	Dieldrin	Endrin	Endosul-phan-II	Endosulphan sulphate
Control 1	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
Control 2	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
Transect 5.5											
T 5.5-100m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T 5.5-125m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T 5.5-150m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T 5.5-175m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T 5.5-200m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T 5.5-250m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T 5.5-300m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T 5.5-350m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T 5.5-400m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T 5.5-500m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
Transect 7/9											
T 7/9-150m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T 7/9-185m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T 7/9-220m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T 7/9-255m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T 7/9-290m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T 7/9-360m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
Transect EF											
T EF-100m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T EF-125m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T EF-150m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T EF-175m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T EF-200m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T EF-250m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T EF-300m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
Transect CD											
T CD-150m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T CD-185m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T CD-220m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T CD-255m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W
T CD-290m	5<W	5<W	5<W	5<W	1<W	2<W	2<W	4<W	4<W	4<W	1<W

<W - below detection limit <T - trace amount

Table 7: Chlorophenol Concentrations in Surficial Sediment Samples. Phase I (July 1995). Northern Wood Preservers, Thunder Bay. All concentrations in ng/g dry weight.

	2,3,4-Tri-chloro-phenol	2,3,4,5-Tetra-chloro-phenol	2,3,5,6-Tetra-chloro-phenol	2,4,5-Tri-chloro-phenol	2,4,6-Tri-chloro-phenol	Penta-chloro-phenol
Control 1	10<W	10<W	5<W	20<W	10<W	15<T
Control 2	10<W	10<W	5<W	20<W	10<W	5<W
Transect 5.5						
T 5.5-100m	10<W	10<W	5<W	20<W	10<W	65
T 5.5-125m	10<W	10<W	5<W	20<W	10<W	75
T 5.5-150m	10<W	10<W	5<W	20<W	10<W	80
T 5.5-175m	10<W	10<W	5<W	20<W	10<W	60
T 5.5-200m	10<W	10<W	5<W	20<W	10<W	50
T 5.5-250m	10<W	10<W	5<W	20<W	10<W	40
T 5.5-300m	10<W	10<W	5<W	20<W	10<W	35
T 5.5-350m	10<W	10<W	5<W	20<W	10<W	25
T 5.5-400m	10<W	10<W	5<W	20<W	10<W	25
T 5.5-500m	10<W	10<W	5<W	20<W	10<W	20<T
Transect 7/9						
T 7/9-150m	10<W	10<W	5<W	20<W	10<W	20<T
T 7/9-185m	10<W	10<W	5<W	20<W	10<W	30
T 7/9-220m	10<W	10<W	5<W	20<W	10<W	30
T 7/9-255m	10<W	10<W	5<W	20<W	10<W	20<T
T 7/9-290m	10<W	10<W	5<W	20<W	10<W	25
T 7/9-360m	10<W	10<W	5<W	20<W	10<W	20<T
Transect EF						
T EF-100m	10<W	10<W	5<W	20<W	10<W	80
T EF-125m	10<W	10<W	5<W	20<W	10<W	70
T EF-150m	10<W	10<W	5<W	20<W	10<W	35
T EF-175m	10<W	10<W	5<W	20<W	10<W	35
T EF-200m	10<W	10<W	5<W	20<W	10<W	30
T EF-250m	10<W	10<W	5<W	20<W	10<W	45
T EF-300m	10<W	10<W	5<W	20<W	10<W	15<T
Transect CD						
T CD-150m	10<W	10<W	5<W	20<W	10<W	35
T CD-185m	10<W	10<W	5<W	20<W	10<W	60
T CD-220m	10<W	10<W	5<W	20<W	10<W	40
T CD-255m	10<W	10<W	5<W	20<W	10<W	20<T
T CD-290m	10<W	10<W	5<W	20<W	10<W	5<W

<W - below detection limit <T - trace amount

Table 8: Chlorobenzene Concentrations in Surficial Sediment. Phase I (july 1995). Northern Wood Preservers, Thunder Bay.
All concentrations in ng/g dry weight.

	Hexachloro butadiene	123-tri-chloro-benzene	1234-tetra-chloro-benzene	1235-tetra-chloro-benzene	124-tri-chloro-benzene	1245-tetra-chloro-benzene	135-tri-chloro-benzene	Hexe-chloro-ethene	Penta-chloro-benzene	236-tri-chloro-toluene	245-tri-chloro-toluene	2,6-dichloro benzyl chloride
Control 1	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
Control 2	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
Transect 5.5												
T 5.5-100m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T 5.5-125m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T 5.5-150m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T 5.5-175m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T 5.5-200m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T 5.5-250m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T 5.5-300m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T 5.5-350m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T 5.5-400m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T 5.5-500m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
Transect 7/9												
T 7/9-150m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T 7/9-185m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T 7/9-220m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T 7/9-255m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T 7/9-290m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T 7/9-360m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
Transect EF												
T EF-100m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T EF-125m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T EF-150m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T EF-175m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T EF-200m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T EF-250m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T EF-300m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
Transect CD												
T CD-150m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T CD-185m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T CD-220m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T CD-255m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W
T CD-290m	1<W	2<W	1<W	1<W	2<W	1<W	2<W	1<W	1<W	1<W	1<W	1<W

<W - below detection limit

Table 9: Dioxin and Furan Concentrations in Surficial Sediment. Phase I (July 1995) and II (September 1995). Northern Wood Preservers, Thunder Bay. All concentrations in pg/g (ppt) dry weight.

		T4CDF	T4CDD	P5CDF	P5CDD	H6CDF	H6CDD	H7CDF	H7CDD	OCDF	OCDD
Control 1	Phase I	3.6 I1	3.4 I1	9.2 I1	6.4 I2	130 I7	60 I3	510 I2	850 I2	500	2900
Control 1	Phase II	6.8 I1	7 I2	9.6 I1	10 I3	120 I2	100 I6	620 I2	890 I2	500	3000
Transect 5.5											
T 5.5-25m	Phase II	9<	5<	10<	65 I5	3100 I4	2700 I6	21000 I2	46000 I2	24000	120000
T 5.5-50m	Phase II	10<	6<	10<	19 I1	1600 I3	1600 I6	9700 I3	25000 I2	11000	90000
T 5.5-75m	Phase II	10<	5<	29 I1	34 I1	3500 I5	2900 I7	22000 I3	48000 I2	25000	170000
T 5.5-100m	Phase II	8<	5<	20<	41 I2	1800 I3	1300 I7	11000 I3	25000 I2	11000	83000
T 5.5-100m	Phase I	2<	1.6 I1	19 I1	27 I4	1300 I4	1000 I6	7600 I3	16000 I2	7900	61000
T 5.5-125m	Phase I	4<	3<	14 I1	27 I6	990 I4	980 I6	6600 I3	16000 I2	7100	58000
T 5.5-150m	Phase I	8<	4.7 I1	38 I3	26 I2	670 I6	540 I6	4200 I3	9100 I2	4700	34000
T 5.5-175m	Phase I	4<	3.4 I2	9.2 I1	18 I5	510 I5	480 I7	3200 I3	6800 I2	3400	26000
T 5.5-200m	Phase I	6.1 I3	2.3 I1	11 I1	16 I4	500 I5	410 I6	2600 I3	5400 I2	2900	21000
T 5.5-250m	Phase I	3<	1.7 I1	11 I1	12 I3	420 I4	350 I7	2100 I3	4400 I2	2200	17000
T 5.5-300m	Phase I	1.6 I1	1<	11 I2	12 I3	370 I6	290 I6	1800 I3	3700 I2	2000	14000
T 5.5-350m	Phase I	2.9 I1	1<	9.6 I1	8.3 I2	290 I4	280 I7	1600 I3	3500 I2	1700	13000
T 5.5-400m	Phase I	6.5 I1	3<	10 I1	15 I2	310 I6	250 I6	1500 I2	3200 I2	1700	12000
T 5.5-500m	Phase I	3<	1.6 I1	10<	12 I3	300 I5	260 I6	1600 I3	3300 I2	1500	12000
Transect 7/9											
T 7/9-35m	Phase II	2.4 I1	7.0 I4	69 I9	67 I12	2800 I8	2700 I7	23000 I3	37000 I2	22000	180000
T 7/9-70m	Phase II	3.2 I2	2.2 I1	50 I6	49 I12	1700 I8	1500 I7	13000 I3	20000 I2	13000	97000
T 7/9-105m	Phase II	3.2 I2	1.7 I1	32 I5	36 I12	1000 I7	960 I7	8600 I3	13000 I2	7800	58000
T 7/9-150m	Phase II	5.3 I3	6.3 I4	27 I4	20 I6	600 I8	540 I7	3100 I3	4900 I2	3600	23000
Transect EF											
T EF-25m	Phase II	20<	10<	30<	17 I1	9200 I4	7400 I6	62000 I3	140000 I2	68000	370000
T EF-50m	Phase II	10<	5<	20<	32 I2	2500 I3	2500 I6	17000 I3	40000 I2	17000	120000
T EF-75m	Phase II	10<	6<	10<	17 I1	1200 I4	1100 I7	7600 I3	16000 I2	8600	62000
T EF-100m	Phase II	2<	1<	9.8 I2	17 I3	590 I4	550 I6	3600 I3	8900 I2	4400	32000
T EF-150m	Phase I	5<	2.2 I1	7.9 I1	12 I3	390 I4	330 I6	2400 I2	4900 I2	2600	18000
T EF-200m	Phase I	3<	2<	8.7 I1	8.3 I1	310 I5	250 I6	1800 I3	3700 I2	2000	15000
T EF-250m	Phase I	2<	14 I2	4<	10 I2	220 I3	210 I7	1300 I3	2800 I2	1500	9600
T EF-300m	Phase I	1<	1.7 I1	5.9 I1	6.3 I1	140 I3	120 I5	800 I3	1600 I2	960	5800
Transect DE											
T DE-25m	Phase II	4.6 I3	8.2 I5	54 I7	51 I11	1200 I9	980 I7	7900 I3	14000 I2	8000	67000
T DE-50m	Phase II	1.7 I1	1.5 I1	36 I8	32 I10	870 I8	760 I7	6900 I3	11000 I2	6600	52000
T DE-75m	Phase II	3.7 I2	7.1 I4	38 I7	29 I11	800 I8	680 I7	5500 I3	9400 I2	5300	45000
T DE-100m	Phase II	4.0 I1	6.5 I4	39 I5	19 I6	890 I9	690 I7	9900 I3	10000 I2	9500	54000

< = less than detection limit
I(+number) = number of isomers detected

Table 10: Dioxin and Furan Concentrations in Surficial Sediment. Phase I (July 1995) and Phase II (September 1995). Northern Wood Preservers, Thunder Bay. All concentrations in pg/g (ppt) dry weight.

Station		2378-TCDF	2378-TCDD	12378-PCDF	23478-PCDF	12378-PCDD	123478-HCDF	123678-HCDF	234678-HCDF	123789-HCDF
I-TEF		0.1	1	0.05	0.5	0.5	0.1	0.1	0.1	0.1
Control 1	Phase I	3.6	2<	1<	1<	2<	5<	3	4.7	2.1
Control 1	Phase II	6.8	2<	4<	3<	2.2	6<	4<	4<	4<
Transect 5.5										
T 5.5-25m	Phase II	9<	5<	10<	10<	12	85	20<	48	10<
T 5.5-50m	Phase II	10<	6<	10<	10<	7<	56	10<	50<	10<
T 5.5-75m	Phase II	10<	5<	20<	20<	10<	89	10<	40	20<
T 5.5-100m	Phase II	8<	5<	20<	20<	6<	40<	10<	10<	10<
T 5.5-100m	Phase I	2<	1<	1<	2<	5<	28	10<	40<	1<
T 5.5-125m	Phase I	4<	2<	1<	2<	3.9	30<	10	20<	8<
T 5.5-150m	Phase I	8<	4.7	13	12	15	22	10<	12	8
T 5.5-175m	Phase I	4<	2<	1<	1<	3.6	20	8<	20<	1<
T 5.5-200m	Phase I	3<	1<	1<	1<	1.7	21	7.3	8<	2<
T 5.5-250m	Phase I	3<	1<	1<	1<	2<	15	9<	10<	3<
T 5.5-300m	Phase I	1<	1<	1<	1<	2<	13	6	11	4<
T 5.5-350m	Phase I	2.9	1<	1<	1<	2<	10<	6.1	7<	2<
T 5.5-400m	Phase I	6.5	3<	9<	6<	7	13	6.7	10	3<
T 5.5-500m	Phase I	3<	1<	1<	1<	2.9	10	6.9	6<	1<
Transect 7/9										
T 7/9-35m	Phase II	2.4	1.4	2.3	3.2	8.0	72	17	19	1<
T 7/9-70m	Phase II	2.2	1.0<	1.5	1.9	4.7	41	10	11	1<
T 7/9-105m	Phase II	2.1	1.0<	1.0<	1.4	5.3	26	6.4	7.0	1<
T 7/9-150m	Phase II	2.2	1.3	1.0<	1.0<	2.6	17	4.9	4.9	1<
Transect EF										
T EF-25m	Phase II	20<	10<	30<	30<	20<	200	30<	110	30<
T EF-50m	Phase II	10<	5<	10<	20<	7<	60<	60<	40<	10
T EF-75m	Phase II	10<	6<	10<	10<	6<	35	10<	19	10<
T EF-100m	Phase I	2<	1<	1<	1.7	2.7	20	6<	9<	5<
T EF-150m	Phase I	5<	2<	3<	3<	2.3	14	7<	10<	3<
T EF-200m	Phase I	3<	2<	1<	1<	1<	13	4<	9.5	3<
T EF-250m	Phase I	1<	1<	1<	1<	1<	9.6<	3.5	7<	2<
T EF-300m	Phase I	1<	1<	3<	3<	1<	7<	2<	4<	1<
Transect DE										
T DE-25m	Phase II	2.0	1.0<	1.9	3.0	6.9	38	8.9	9.4	1<
T DE-50m	Phase II	1.7	1.0<	1.3	1.6	4.0	25	6.8	6.7	1<
T DE-75m	Phase II	2.6	1.0<	2.2	2.4	3.9	28	8.1	9.1	3.0
T DE-100m	Phase II	4.0	3.0	9.9	8.3	9.6	27	11	9.8	4.1

< = less than detection limit

Table 10: cont'd. All concentrations in pg/g dry weight.

Station		123478-HCDD	123678-HCDD	123789-HCDD	1234678-HCDF	1234789-HCDF	1234678-HCDD	OCDF	OCDD	Total TEQ
I-TEF		0.1	0.1	0.1	0.01	0.01	0.01	0.001	0.001	
Control 1	Phase I	3<	20<	9.8	170	5<	430	500	2900	11.7
Control 1	Phase II	4.3	15	7.8	210	7<	460	500	3000	14.7
Transect 5.5										
T 5.5-25m	Phase II	30<	500	140	3500	260	19000	24000	120000	454.9
T 5.5-50m	Phase II	30<	280	86	1800	120	10000	11000	90000	262.4
T 5.5-75m	Phase II	28	530	130	3900	240	20000	25000	170000	518.1
T 5.5-100m	Phase II	24	280	74	2100	130	11000	11000	83000	264.1
T 5.5-100m	Phase I	20<	200	53	1400	110	6700	7900	61000	179.1
T 5.5-125m	Phase I	14	190	46	1200	75	6000	7100	58000	165.8
T 5.5-150m	Phase I	17	120	38	800	39	3800	4700	34000	125.6
T 5.5-175m	Phase I	11	90	32	680	38	3100	3400	26000	84.7
T 5.5-200m	Phase I	7<	74	26	550	30	2400	2900	21000	67.4
T 5.5-250m	Phase I	7.8	63	20	440	22	2000	2200	17000	54.4
T 5.5-300m	Phase I	6<	57	20	430	23	1700	2000	14000	48.2
T 5.5-350m	Phase I	9.7	49	20	370	23	1600	1700	13000	43.4
T 5.5-400m	Phase I	10<	44	17	360	20<	1500	1700	12000	45.5
T 5.5-500m	Phase I	9	40	19	390	26	1400	1500	12000	41.6
Transect 7/9										
T 7/9-35m	Phase II	35	540	110	3300	210	15000	22000	180000	472.3
T 7/9-70m	Phase II	19	310	60	1800	110	8400	13000	97000	261.8
T 7/9-105m	Phase II	10	190	43	1200	64	5300	7800	58000	163.2
T 7/9-150m	Phase II	7.7	100	25	670	40	2100	3600	23000	73.5
Transect EF										
T EF-25m	Phase II	60<	1400	260	9900	640	58000	68000	370000	1320.4
T EF-50m	Phase II	20<	500	110	2800	210	16000	17000	120000	389.1
T EF-75m	Phase II	14	220	51	1400	92	7300	8600	62000	192.4
T EF-100m	Phase I	7.7	100	28	770	39	3500	4400	32000	97.3
T EF-150m	Phase I	5<	61	21	440	30<	2000	2600	18000	55.7
T EF-200m	Phase I	3.4	50	14	330	14	1700	2000	15000	46.4
T EF-250m	Phase I	4.9	34	11	260	15	1200	1500	9600	31.2
T EF-300m	Phase I	2.5	21	8<	160	11	680	960	5800	17.6
Transect DE										
T DE-25m	Phase II	18	200	56	1800	76	6400	8000	67000	196.0
T DE-50m	Phase II	13	160	40	1000	65	5200	6600	52000	149.4
T DE-75m	Phase II	12	140	33	890	47	4100	5300	45000	127.5
T DE-100m	Phase II	15	190	33	1400	100	5500	9500	54000	175.3

< = less than detection limit

Table 11: Metals Concentrations in Surficial Sediments. Phase I (July 1995). Northern Wood Preservers - Thunder Bay. Concentrations in ug/g dry weight unless otherwise noted.

	LOI mg/g	Al	Cd	Cr	Cu	Fe	Pb	Hg	Mn	Ni	Zn
Control 1	58	24000	1.4	66	61	39000	25	0.24	710	40	160
T 5.5-100	43	22000	1.2	56	59	32000	31	0.24	370	36	140
T 5.5-125	45	21000	1.4	79	57	32000	31	0.21	380	44	140
T 5.5-150	38	21000	1.3	53	59	31000	31	0.22	350	36	140
T 5.5-175	45	21000	1.2	56	58	34000	29	0.23	400	36	140
T 5.5-200	41	21000	3.9	59	61	35000	31	0.25	440	41	140
T 5.5-250	38	21000	1.4	56	59	34000	30	0.23	400	36	140
T 5.5-300	43	22000	1.6	57	61	37000	35	0.22	460	37	160
T 5.5-350	40	21000	1.4	56	60	36000	43	0.27	430	36	140
T 5.5-400	42	21000	1.4	57	61	36000	35	0.21	420	38	150
T 5.5-500	45	23000	1.8	59	69	39000	37	0.2	640	41	160
T 7/9-150	50	23000	1.3	60	58	39000	24	0.17	630	39	140
T 7/9-185	27	22000	1.1	55	58	35000	21	0.21	530	37	130
T 7/9-220	39	22000	1.3	59	56	38000	23	0.18	660	39	130
T 7/9-255	36	22000	1.2	58	56	37000	22	0.17	620	39	130
T 7/9-290	32	22000	1.5	57	62	37000	21	0.18	640	42	140
T 7/9-360	25	21000	1.3	52	56	34000	15	0.25	600	41	130
T EF-100	56	21000	1.2	56	52	37000	22	0.17	550	37	120
T EF-125	48	22000	1.1	56	55	37000	20	0.17	560	38	130
T EF-150	40	21000	1.4	56	51	35000	20	0.15	520	38	120
T EF-175	38	22000	1.3	55	49	36000	15	0.14	520	36	120
T EF-200	37	22000	1.4	55	50	36000	18	0.13	590	37	120
T EF-250	22	22000	0.8	54	43	33000	22	0.12	430	38	100
T EF-300	25	22000	1.0	56	43	36000	17	0.11	560	40	100
T CD-150	56	20000	1.2	53	49	36000	18	0.16	460	36	120
T CD-185	44	20000	1.0	51	44	34000	18	0.12	500	36	100
T CD-220	42	21000	1.2	52	46	35000	15	0.12	500	36	110
T CD-255	36	23000	1.1	58	43	36000	12	0.09	600	40	100
T CD-290	16	21000	0.9	48	45	32000	8	0.06	580	35	73

Table 12: Distribution of Major Benthic Taxa. Phase I. (No./m^2)

Taxa:	T5-5 100	T5-5 125	T5-5 150	T5-5 175	T5-5 200	T5-5 250	T5-5 300	T5-5 350	T5-5 400	T5-5 500
Trichoptera:										
Diptera:										
Chironomidae:	404	596	1083	282	391	1680	1128	615	974	1154
Hydrachnida:							6			
Amphipoda:	250	64	64	179	109	96	38	45	64	19
Isopoda:	455	423	115	410	346	186	147	147	96	19
Oligochaeta:	449	436	526	962	333	878	1109	769	846	474
Gastropoda:	71	90	250	141	115			32	13	
Pelecypoda	404	359	551	1141	295	186	301	71	115	128
Total Organisms	2032	1968	2590	3115	1590	3026	2731	1680	2109	1795

Taxa:	T7-9 150	T7-9 185	T7-9 220	T7-9 255	T7-9 290	T7-9 360	T-EF 100	T-EF 125	T-EF 150	T-EF 175
Trichoptera:				6	6	6	6			
Diptera:										
Chironomidae:	186	141	436	314	429	827	487	635	103	385
Hydrachnida:			6	13	13	6			13	6
Amphipoda:	19									
Isopoda:							6			
Oligochaeta:	1686	199	1378	1199	737	545	1756	1449	1699	1045
Gastropoda:	141	96	141	45	19	45			38	13
Pelecypoda	1571	391	1058	699	269	301	423	667	776	224
Total Organisms	3603	827	3019	2276	1474	1731	2680	2750	2628	1673

Taxa:	T-EF 200	T-EF 250	T-EF 300	T-CD 150	T-CD 185	T-CD 220	T-CD 255	T-CD 290	C-2	C-1
Trichoptera:				13	6	6				90
Diptera:										
Chironomidae:	58	109	71	276	103	353	115	109	1551	1154
Hydrachnida:				13						13
Amphipoda:										64
Isopoda:				19					6	19
Oligochaeta:	647	205	167	558	468	712	365	288	551	487
Gastropoda:					19		13			38
Pelecypoda	64	13		365	83	263	26	26	641	173
Total Organisms	769	327	237	1244	679	1333	519	423	2750	2038

Table 12: Distribution of Major Benthic Taxa. Phase II. (No./m^2)

Taxa:	T5.5 25	T5.5 50	T5.5 75	T5.5 100	T7/9 35	T7/9 70	T7/9 105	T7/9 150
Trichoptera	308	173	51	160	77	83	77	26
Diptera:								
Chironomidae	173	128	288	314	71	160	410	244
Hydrachnida						6		
Amphipoda	19	237	192	263		6		
Isopoda:	3301	3397	2769	3353	596	551	346	13
Gastropoda	26	160	500	71	19	218	237	365
Pelecypoda	1090	1218	686	840	417	321	301	519
Hirudinea				6				
Oligochaeta	1667	378	423	1769	1135	718	897	1365
Total No Organisms	6583	5692	4910	6776	2314	2064	2269	2532

Taxa:	T-EF 50	T-EF 75	T6/7 35	T6/7 70	T6/7 105	T6/7 140	Control C1
Trichoptera	77	71	417	115	64	19	71
Diptera:							
Chironomidae	500	237	237	353	526	147	1423
Hydrachnida	6					13	38
Amphipoda		6			13		
Isopoda:	212		1718	917	417	32	167
Gastropoda	83	90				58	58
Pelecypoda	359	462	391	455	571	872	147
Hirudinea							
Oligochaeta	2378	1827	2147	769	865	1077	429
Total No Organisms	3615	2692	4910	2609	2455	2218	2333

Table 13: Distribution of Benthic Taxa. Phase I. Northern Wood Preservers, Thunder Bay. All values in #/m^2.

Transect	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-7/9	T-7/9	T-7/9	T-7/9	T-7/9	T-7/9
Distance (m)	100	125	150	175	200	250	300	350	400	500	150	185	220	225	290	360
PHYLUM ANNELIDA																
CLASS POLYCHAETA:																
Order Sabellida:																
Sabellidae:																
Maneyunkia speciosa			19													
CLASS OLIGOCHAETA																
Order Tubificida:																
Tubificidae:																
Aulodrilus limnobius																
Aulodrilus pluriseta								19		212	58			19		
Ilyodrilus templetoni	19											19				
Limnodrilus cleparedianus												19	19			
Limnodrilus hoffmeisteri	96	135	58	519	77	154	173	135	96	38	346	77	96	38	38	
Limnodrilus sp.																
Potamothrix vejdovskyi																
Quistadrilus multisetosus													154			
Spirosperma ferox	404	231	288	346	423	500	558	577	154	423	635		115	154	77	19
Tubifex tubifex			19								58	19				
immature tubificids with bifid seta	58	96	96	423	96	77	115	173	115	38	635	77	385	250	135	
immature tubificids with hair & pectinate setae	154	135	250	115		96	308	115	423	192	731	58	154	115	19	77
Naididae:																
Ophidonais serpentina												19				
Slavinia appendiculata																
Lumbriculidae:																
Stylodrilus heringianus												38	77	154	269	538
immature lumbriculids with bifid setae												19	58	58	250	692
PHYLUM MOLLUSCA																
CLASS BIVALVIA:																
Sphaeriidae:									38							
Musculium sp.			19			58	173	96	77	58	58					
Pisidium sp.	212	269	442	288	77	173	135	38	77		1288	423	1077	1038	365	212
Sphaerium sp.	77	38	135	2346	212			19	135	77	19	38			19	
CLASS GASTROPODA:																

Table 13: cont'd.

Transect	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-7/9	T-7/9	T-7/9	T-7/9	T-7/9	T-7/9
Distance (m)	100	125	150	175	200	250	300	350	400	500	150	185	220	225	290	360
Hydrobiidae:																
Amnicola limosa	19	58	135	115	38			19								
Lymnaeidae:																
Stagnicola catascopium				19												
Physidae:																
Physa ancillaria								19								
Physa sp.				19									19			
Valvatidae:																
Valvata lewisi											58	19				
Valvata sincera	38	38	96		38								154	77		115
PHYLUM ARTHROPODA																
SUBCLASS MALACOSTRACA																
ORDER AMPHIPODA:						19										
Gammaridae:																
Gammarus fasciatus	231	115			231	58	58	135	173	38						
Haustoriidae:																
Monoporeia affinis										19						
ORDER ISOPODA:																
Asellidae:																
Caecidotea sp.	423	692	135	827	615	231	212	404	154							
SUBCLASS ACARINA											19			19	19	19
CLASS INSECTA																
ORDER TRICHOPTERA:	58	38		38						77				19	19	
Hydropsychidae:																
Chaumatopsyche sp.										19						
Hydropsyche sp.										38						
Limnephilidae:																
cf.Grammotaulius sp.		19														
Phylocentropodidae:																
Phylocentropus sp.	58	19		38						19				19	19	
ORDER DIPTERA																
Chironomidae					19											
Prodiamesinae:																
Monodiamesa sp.	19															

Table 13: cont'd

Transect	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-5.5	T-7/9	T-7/9	T-7/9	T-7/9	T-7/9	T-7/9
Distance (m)	100	125	150	175	200	250	300	350	400	500	150	185	220	225	290	360
Tanypodinae:		19														
Procladius sp.	135	192	19	115	327	250	96	327	77	365	192	96	346	154	19	135
Orthocladiinae:						38	38		19	77		58	19	58	19	135
Heterotrissocladius sp.	77	250	596		19	615	173	154	58	442					96	327
cf.Orthocladius /Cricotopus sp.																
Chironominae:																
Chironomini:				19							19					
Chironomus sp.		19	19	19	58	77	115		58	38						
Cryptochironomus sp.		19	38			19	58				19					
Dicrotendipes sp.		38				19		19	96							
Harnischia sp.	38	19	115	38		19		58	38	115			19		19	
Paratendipes sp.				38	38			19								
Polypedilum sp.	19	19	19			19	58	19	135	19	38	19	96	19	154	77
Tanytarsini:																
Cladotanytarsus sp.																
Micropsectra sp.							77	19								
Tanytarsus sp.	38	154	269			481	154	250	135	250						154
Diamesinae:																
Potthastia longimanus type										19						
Protanypus sp.	19		96			135	77	58	96	135						19
Total No.of Organisms	2192	2615	2865	5327	2269	3038	2577	2673	2154	2712	4173	1000	2788	2192	1538	2519
Total No of Taxa	17	19	18	14	13	17	15	19	17	19	13	12	12	11	12	11

Table 13: Distribution of Benthic Taxa

Transect	T-EF	T-EF	T-EF	T-EF	T-EF	T-EF	T-EF	T-CD	T-CD	T-CD	T-CD	T-CD	Control:	Control:
Distance (m)	100	125	150	175	200	250	300	150	185	220	255	290	InnerGap	MainGap:
PHYLUM ANNELIDA														
CLASS POLYCHAETA:														
Order Sabellida:														
Sabellidae:														
Manayunkia speciosa														
CLASS OLIGOCHAETA														
Order Tubificida:														
Tubificidae:														
Aulodrilus limnobius				19										
Aulodrilus pluriseta									19					19
Ilyodrilus templatoni		38							19		19			
Limnodrilus claparedianus														
Limnodrilus hoffmeisteri	327	346	231			19		269	38		19	38	96	96
Limnodrilus sp.		38												
Potamothrix vejdovskyi				58										
Quistadrilus multisetosus	77	38	77	154					38					
Spirosperma ferox	192	269	77	58	38	19		19		38	38		385	288
Tubifex tubifex		77	38	19				19		19	19	19		
Immature tubificids with bifid seta	635	942	904	212	38			346	154	327	38	77	115	135
immature tubificids with hair & pectinate setae	673	154	750	404		19		135	115	423	19	77	19	269
Naididae:														
Ophidonais serpentina									58			19		
Slavinia appendiculata								19						
Lumbriculidae:														
Stylodrilus heringianus			154	19	327	308	288			38	19		19	
Immature lumbriculids with bifid setae			77	77	212	135	173			19		135		
PHYLUM MOLLUSCA														
CLASS BIVALVIA:														
Sphaeriidae:														
Musculium sp.										19		19		
Pisidium sp.	135	635	942	288	38			269	77	385	38	19	654	38
Sphaerium sp.	115	96	77	58				77						
CLASS GASTROPODA:														

Table 13: cont'd.

Transect Distance (m)	T-EF 100	T-EF 125	T-EF 150	T-EF 175	T-EF 200	T-EF 250	T-EF 300	T-CD 150	T-CD 185	T-CD 220	T-CD 255	T-CD 290	Control: InnerGap	Control: MainGap:
Hydrobiidae:														
Amnicola limosa														
Lymnaeidae:														
Stagnicola catascopium														
Physidae:														
Physa ancillaria														
Physa sp.														
Valvatidae:														
Valvata lewisi											19			
Valvata sincera			38	19					38					77
PHYLUM ARTHROPODA														
SUBCLASS MALACOSTRACA														
ORDER AMPHIPODA:														
Gammaridae:														
Gammarus fasciatus														
Haustoriidae:														
Monoporeia affinis														58
ORDER ISOPODA:														
Asellidae:														
Caecidotea sp.	19							58					19	
SUBCLASS ACARINA			19	19										19
CLASS INSECTA														
ORDER TRICHOPTERA:	19							19		19				38
Hydropsychidae:														
Chaumatopsyche sp.														
Hydropsyche sp.														
Limnephilidae:														
cf.Grammotaulius sp.														
Phylocentropodidae:														
Phylocentropus sp.	19							19		19				38
ORDER DIPTERA														
Chironomidae												38		
Prodiamesinae:														
Monodiamesa sp.						38	58							

Table 13: cont'd.

Transect Distance (m)	T-EF 100	T-EF 125	T-EF 150	T-EF 175	T-EF 200	T-EF 250	T-EF 300	T-CD 150	T-CD 185	T-CD 220	T-CD 255	T-CD 290	Control: InnerGap	Control: MainGap:
Tanypodinae:														
Procladius sp.	404	808	77	385	77	38	38	404	77	385	154	115	635	96
Orthocladiinae:	19												19	19
Heterotrissocladius sp.	58	19				96		19					250	538
cf.Orthocladius /Cricotopus sp.													654	327
Chironominae:														
Chironomini:								19						19
Chironomus sp.		38						38		19			19	19
Cryptochironomus sp.							19	77					19	
Dicrotendipes sp.													19	
Harnischia sp.	77					19						19	19	19
Paratendipes sp.														38
Polypedilum sp.	173	38	19	58		96	19	19	38	115	77	19	38	58
Tanytarsini:														
Cladotanytarsus sp.														
Micropsectra sp.														
Tanytarsus sp.								19						38
Diamesinae:														
Potthastia longimanus type														
Protanypus sp.						19								
Total No. of Organisms	2942	3539	3481	1846	731	808	596	1846	673	1827	462	596	2981	2250
Total No of Taxa	12	12	11	12	4	9	5	15	9	9	9	9	14	18

Table 13: Distribution of Benthic Taxa. Phase II. Northern Wood Preservers, Thunder Bay. All values in #/m^2.

	T5.5 25	T5.5 50	T5.5 75	T5.5 100	T7/9 35	T7/9 70	T7/9 105	T7/9 150
PHYLUM ANNELIDA								
CLASS OLIGOCHAETA								
Order Tubificida:								
Tubificidae:								
Aulodrilus limnobius								
Aulodrilus pluriseta		19					38	19
Ilyodrilus templetoni								
Limnodrilus claparedianus								
Limnodrilus hoffmeisteri	192	96	58	269	442	38	77	
Limnodrilus sp.								
Potamothrix moldaviensis								
Potamothrix vejdovskyi								
Quistadrilus multisetosus	192							
Spirosperma ferox	19	19	346	596		115	231	808
Tubifex tubifex								
immature tubificids with bifid seta	904	404	96	577	519	385	365	346
immature tubificids with hair & pectinate seta	19	19			58	115	154	77
Naididae:								
Ophidonais serpentina						19	77	19
Slavinia appendiculata								
Lumbriculidae:								
Stylodrilus heringianus								
immature lumbriculids with bifid seta								19
CLASS HIRUDINEA								
Order Rhynchobdellida:								
Glossiphoniidae:								
Glossiphonia complanata				19				
PHYLUM MOLLUSCA								
CLASS BIVALVIA:								
Sphaeriidae:								
Pisidium sp.	635	1269	769	481		250	58	538
Pisidium/Sphaerium sp.	538	904	481	250	135	385	115	269
CLASS GASTROPODA:								
Hydrobiidae:								
Amnicola limosa Say			250	38			19	
Lymnaeidae:								
Stagnicola catascopium (Say)		19	192			19	231	19
Physidae:								
Physa sp.							19	
Valvatidae:								
Valvata lewisi Currier		269	96	19		365	173	558
PHYLUM ARTHROPODA								
SUBCLASS MALACOSTRACA								
ORDER AMPHIPODA:								
Gammaridae:								
Gammarus fasciatus Say		423	346	135		19		
ORDER ISOPODA:								
Asellidae:								
Caecidotea communis	2231	6058	2692	4000	327	981	173	38

	T5.5 25	T5.5 50	T5.5 75	T5.5 100	T7/9 35	T7/9 70	T7/9 105	T7/9 150
SUBCLASS ACARINA						19		
CLASS INSECTA								
ORDER TRICHOPTERA:								
Hydroptilidae:								
Agraylea sp.								
Phryganeidae:								
Phryganea sp.			58					
Phylocentropodidae:								
Phylocentropus sp.	154	212	58	212	58	115	38	38
ORDER DIPTERA								
Chironomidae								
Diamesinae:								
Potthastia sp.							38	19
Protanypus sp.						19		
Tanypodinae:								
Ablabesmyia sp.						19		19
Procladius sp.		19	96	38		58	250	115
Chironominae:								
Chironomus sp.	19			96			58	19
Cryptochironomus sp.	77		58	38	135	38	19	19
Dicrotendipes sp.								
Endochironomus sp.			58					
Glyptotendipes sp.		19				19	19	
Phaenopsectra sp.				19				
Polypedilum sp.		154	154	19		19	19	96
Stictochironomus sp.		19	96	96				
Tanytarsini:								
Micropsectra sp.							19	
Tanytarsus sp.		19					19	19
Total No. Organisms	4981	9942	5904	6904	1673	3000	2212	3058
Total No. of Taxa	9	15	16	16	5	17	20	16

Table 13: Phase II. cont'd.

	T-EF 50	T-EF 75	T6/7 35	T6/7 70	T6/7 105	T6/7 140	Control C1
PHYLUM ANNELIDA							
CLASS OLIGOCHAETA							
Order Tubificida:							
Tubificidae:							
Aulodrilus limnobius							
Aulodrilus pluriseta	38	115			19		
Ilyodrilus templetoni							
Limnodrilus claparedianus							
Limnodrilus hoffmaisteri	231	192		58	135	19	19
Limnodrilus sp.							
Potamothrix moldaviensis					19		
Potamothrix vejdovskyi					19		
Quistadrilus multisetosus	154	192			19	38	
Spirosperma ferox		38		58	96	288	212
Tubifax tubifex							
immature tubificids							
with bifid seta	1692	885	288	442	500	212	173
immature tubificids							
with hair & pectinate seta	231	269	19	96	212	135	58
Naididae:							
Ophidonais serpentina		231					
Slavinia appendiculata							
Lumbriculidae:							
Stylodrilus heringianus							
immature lumbriculids							
with bifid seta					19		
CLASS HIRUDINEA							
Order Rhynchobdellida:							
Glossiphoniidae:							
Glossiphonia complanata							
PHYLUM MOLLUSCA							
CLASS BIVALVIA:							
Sphaeriidae:							115
Pisidium sp.	346	250	442	231	481	1096	77
Pisidium/Sphaerium sp.	19	58		212	519	462	
CLASS GASTROPODA:							
Hydrobiidae:							
Amnicola limosa Say							
Lymnaeidae:							
Stagnicola catascopium (Say)	154	58					
Physidae:							
Physa sp.	19	19				19	
Valvatidae:							
Valvata lewisi Currier		77				135	77
PHYLUM ARTHROPODA							
SUBCLASS MALACOSTRACA							
ORDER AMPHIPODA:							
Gammaridae:							
Gammarus fasciatus Say		19			38		
ORDER ISOPODA:							
Asellidae:							
Caecidotea communis	192		1154	635	462	38	231

	T-EF 50	T-EF 75	T6/7 35	T6/7 70	T6/7 105	T6/7 140	Control C1
SUBCLASS ACARINA						19	77
CLASS INSECTA							
ORDER TRICHOPTERA:							
Hydroptilidae:							
Agraylea sp.		19					
Phryganeidae:							
Phryganea sp.							
Phylocentropodidae:							
Phylocentropus sp.	77	77	327	115	77	19	58
ORDERDIPTERA							
Chironomidae							
Diamesinae:							
Potthastia sp.				19		58	19
Protanypus sp.							
Tanypodinae:							
Ablabesmyia sp.					19		
Procladius sp.	154	19	192	173	154	19	365
Chironominae:							
Chironomus sp.	500				77	19	981
Cryptochironomus sp.	135	19	58	58	58	19	
Dicrotendipes sp.							
Endochironomus sp.							
Glyptotendipes sp.							
Phaenopsectra sp.							231
Polypedilum sp.	19	77		19	19		19
Stictochironomus sp.				19			
Tanytarsini:							
Micropsectra sp.							
Tanytarsus sp.							77
Total No. Organisms	3962	2615	2481	2135	2942	2596	2788
Total No. of Taxa	13	16	5	11	17	14	14

TABLE 14. Mean (+/− s.d.) water quality characteristics in sediment bioassays for Phase I (July 1995).

Test Organism: Mayfly (Hexagenia limbata)[a] Test Temperature: 20.7 (0.7) Celsius[d]

Station	*pH*	*D.O.* mg/L	*Conductivity* umho/cm	*Total Ammonia* mg/L	*Un−ionized Ammonia* mg/L
Control	7.81 (.23)	8.4 (0.2)	318 (10)	<0.10	<0.003
Reference	7.97 (.05)	8.4 (0.2)	298 (15)	0.12 (0.05)	0.004
Stn T5.5−100	8.21 (.07)	8.4 (0.2)	348 (31)	0.10 (0.01)	0.004
Stn T5.5−125	8.25 (.06)	8.5 (0.2)	342 (24)	0.10 (0.01)	0.006
Stn T5.5−150	8.26 (.07)	8.5 (0.2)	357 (40)	<0.10	0.007
Stn T5.5−175	8.15 (.09)	8.3 (0.1)	361 (45)	<0.10	0.004
Stn T5.5−200	8.04 (.09)	8.4 (0.1)	322 (24)	0.12 (0.04)	0.004
Stn T5.5−250	8.07 (.09)	8.4 (0.2)	377 (63)	<0.10	0.004
Stn T5.5−300	8.06 (.08)	8.4 (0.2)	375 (59)	<0.10	0.003
Stn T5.5−350	8.09 (.09)	8.5 (0.1)	366 (49)	<0.10	0.003
Stn T5.5−400	8.05 (.08)	8.4 (0.2)	357 (44)	<0.10	0.003
Stn T5.5−500	8.04 (.13)	8.4 (0.1)	356 (32)	0.12 (0.05)	0.004

Test Organism: Midge (Chironomus tentans)[b] Test Temperature: 20.8 (0.5) Celsius

Station	*pH*	*D.O.* mg/L	*Conductivity* umho/cm	*Total Ammonia* mg/L	*Un−ionized Ammonia* mg/L
Control	7.83 (.12)	8.4 (0.1)	335 (13)	0.18 (0.07)	0.006
Reference	7.84 (.28)	8.1 (0.6)	321 (27)	0.15 (0.05)	0.004
Stn T5.5−100	8.04 (.04)	8.3 (0.1)	335 (13)	0.24 (0.22)	0.009
Stn T5.5−125	8.15 (.05)	8.5 (0.1)	340 (14)	0.28 (0.23)	0.010
Stn T5.5−150	8.11 (.08)	8.4 (0.2)	353 (27)	0.28 (0.26)	0.010
Stn T5.5−175	8.13 (.07)	8.5 (0.1)	348 (23)	0.16 (0.10)	0.009
Stn T5.5−200	8.04 (.01)	8.5 (0.1)	325 (14)	0.13 (0.05)	0.005
Stn T5.5−250	8.11 (.04)	8.5 (0.1)	357 (32)	0.15 (0.09)	0.005
Stn T5.5−300	8.00 (.08)	8.3 (0.2)	358 (44)	0.15 (0.09)	0.005
Stn T5.5−350	8.07 (.06)	8.4 (0.1)	347 (29)	0.18 (0.13)	0.006
Stn T5.5−400	8.01 (.05)	8.5 (0.1)	345 (23)	0.14 (0.07)	0.005
Stn T5.5−500	8.09 (.05)	8.4 (0.1)	359 (32)	0.18 (0.14)	0.006

a Sample size N=4; b Sample size N=3;

d Based on daily recorded temperature measured during the test period.

Underlining indicates un−ionized ammonia concentrations that exceed the PWQO of 0.02 mg/L

TABLE 14. Continued.

Test Organism: Minnow (Pimephales promelas) [c] Test Temperature: 20.1 (1.0) Celsius [d]

Station	*pH*	*D.O.* mg/L	*Conductivity* umho/cm	*Total Ammonia* mg/L	*Un-ionized Ammonia* mg/L
Control	7.04 (.66)	8.3 (0.2)	344 (27)	1.34 (0.56)	0.017
Reference	7.57 (.21)	8.4 (0.1)	336 (38)	2.08 (1.32)	0.039
Stn T5.5-100	7.87 (.13)	7.8 (0.4)	392 (52)	5.84 (4.70)	0.172
Stn T5.5-125	7.94 (.12)	8.4 (0.1)	381 (42)	3.48 (4.70)	0.122
Stn T5.5-150	7.91 (.20)	8.1 (0.6)	399 (48)	4.28 (3.24)	0.189
Stn T5.5-175	7.82 (.11)	8.3 (0.3)	398 (67)	3.36 (2.66)	0.107
Stn T5.5-200	7.66 (.09)	8.3 (0.3)	360 (41)	1.63 (0.96)	0.033
Stn T5.5-250	7.68 (.17)	8.2 (0.6)	402 (58)	1.44 (1.35)	0.026
Stn T5.5-300	7.73 (.15)	8.4 (0.1)	413 (69)	0.69 (0.43)	0.019
Stn T5.5-350	7.62 (.36)	7.3 (2.6)	400 (63)	1.24 (1.20)	0.027
Stn T5.5-400	7.73 (.13)	8.3 (0.2)	390 (52)	0.54 (0.41)	0.012
Stn T5.5-500	7.68 (.17)	8.0 (0.3)	401 (51)	1.41 (1.72)	0.041

c Sample size N=5;

d Based on daily recorded temperature measured during the test period.

Underlining indicates un-ionized ammonia concentrations that exceed the PWQO of 0.02 mg/L

TABLE 14. Continued.

Mean (+/− s.d.) water quality characteristics in sediment bioassays for Phase II (September 1995).

[a] *Test Organism: Mayfly (Hexagenia limbata)* — Test Temperature: 20.2 (1.3) Celsius [d]

Station	*pH*	*D.O.* mg/L	*Conductivity* umho/cm	*Total Ammonia* mg/L	*Un−ionized Ammonia* mg/L
Control	7.83 (.14)	8.8 (0.3)	334 (12)	<0.10	<0.003
Reference	7.88 (.06)	8.7 (0.3)	303 (25)	0.18 (0.16)	0.005
Stn T5.5−25	7.95 (.12)	8.7 (0.3)	266 (7)	0.67 (0.45)	0.021
Stn T5.5−50	8.11 (.26)	8.3 (0.9)	335 (56)	0.16 (0.14)	0.006
Stn T5.5−75	8.17 (.16)	8.6 (0.3)	321 (6)	0.16 (0.06)	0.007
Stn TEF−25	7.79 (.22)	8.7 (0.5)	279 (6)	0.66 (0.02)	0.018
Stn TEF−50	8.04 (.13)	8.6 (0.4)	285 (11)	0.36 90.35)	0.042
Stn TEF−75	8.06 (.16)	8.6 (0.4)	297 (22)	0.24 (0.24)	0.008

[b] *Test Organism: Midge (Chironomus tentans)* — Test Temperature: 20.8 (1.3) Celsius

Station	*pH*	*D.O.* mg/L	*Conductivity* umho/cm	*Total Ammonia* mg/L	*Un−ionized Ammonia* mg/L
Control	7.91 (.32)	8.2 (0.9)	337 (9)	0.16 (0.05)	0.006
Reference	7.96 (.14)	8.3 (0.7)	312 (17)	0.38 (0.36)	0.013
Stn T5.5−25	7.99 (.05)	8.3 (0.3)	286 (4)	2.90 (1.10)	0.112
Stn T5.5−50	7.94 (.07)	8.0 (0.4)	319 (12)	0.46 (0.30)	0.014
Stn T5.5−75	8.07 (.10)	8.2 (0.6)	337 (11)	1.16 (0.76)	0.044
Stn TEF−25	7.86 (.25)	8.0 (0.4)	294 (2)	2.20 (0.87)	0.072
Stn TEF−50	7.79 (.35)	7.4 (2.0)	292 (8)	2.23 (0.81)	0.062
Stn TEF−75	7.86 (.18)	8.0 (1.0)	294 (4)	1.03 (0.72)	0.038

[c] *Test Organism: Minnow (Pimephales promelas)* — Test Temperature: 21.6 (1.3) Celsius

Station	*pH*	*D.O.* mg/L	*Conductivity* umho/cm	*Total Ammonia* mg/L	*Un−ionized Ammonia* mg/L
Control	7.23 (.24)	7.0 (0.3)	362 (41)	2.07 (0.99)	0.018
Reference	7.45 (.19)	7.0 (0.7)	374 (64)	2.47 (1.89)	0.048
Stn T5.5−25	7.85 (.23)	7.1 (0.6)	365 (77)	9.62 (6.70)	0.389
Stn T5.5−50	7.64 (.21)	6.9 (0.7)	367 (44)	5.62 (4.97)	0.140
Stn T5.5−75	8.15 (.21)	7.2 90.5)	447 (78)	7.32 95.26)	0.728
Stn TEF−25	7.90 (.31)	6.6 (0.7)	409 (82)	9.85 (5.82)	0.386
Stn TEF−50	7.35 (.59)	6.3 (1.5)	349 (36)	4.92 (4.46)	0.101
Stn TEF−75	7.66 (.18)	7.4 (0.2)	330 (25)	2.97 (2.32)	0.082

a Sample size N=5; b Sample size N=3; c Sample size N=4.

d Based on daily recorded temperature measured during the test period.

Underlining indicates un−ionized ammonia concentrations that exceed the PWQO of 0.02 mg/L

TABLE 15. Summary of biological results on mayfly, midge and minnow sediment bioassays for control(s and Thunder Bay Phase I (July 1995) sediments. Mean values (+/− stand. deviation).

Test Organism	*Hexagenia limbata* (Mayfly)		*Chironomus tentans* (Midge)		*Pimephales promelas* (Fathead Minnow)
Station	*% Mortality* (N=3)	*Ave. Individual Body Weight* (mg wet wt.)	*% Mortality* (N=3)	*Ave. Individual Body Weight* (mg wet wt.)	*% Mortality* (N=3)
Control	AB 3.3 (6)	EF 7.81 (0.1)	A 0 (0)	AB 11.36 (0.4)	A 6.6 (6)
Reference	AB 3.3 (6)	DE 10.21 (0.5)	A 6.6 (7)	AB 11.17 (1.0)	A 10.0 (17)
Stn T5.5−100	A 0 (0)	F 6.43 (0.5)	A 17.7 (4)	C 5.74 (0.7)	AB 13.3 (6)
Stn T5.5−125	B 10.0 (0)	F 6.14 (1.2)	A 17.7 (17)	C 5.06 (0.9)	A 6.6 (12)
Stn T5.5−150	A 0 (0)	F 6.16 (0.9)	A 11.0 (4)	C 6.15 (2.2)	B* 66.6 (25)
Stn T5.5−175	A 0 (0)	ABC 14.45 (1.5)	A 0 (0)	B 10.44 (1.2)	AB* 56.6 (23)
Stn T5.5−200	A 0 (0)	AB 15.77 (3.5)	A 0 (0)	A 12.50 (0.8)	A 10.0 (10)
Stn T5.5−250	A 0 (0)	CD 11.47 (2.4)	A 2.2 (4)	AB 11.48 (0.6)	AB 46.6 (31)
Stn T5.5−300	A 0 (0)	BCD 13.03 (0.8)	A 6.6 (12)	B 10.30 (1.3)	AB 46.6 (12)
Stn T5.5−350	A 0 (0)	BCD 12.15 (1.2)	A 4.4 (4)	B 9.71 (3.7)	AB 33.3 (15)
Stn T5.5−400	AB 3.3 (6)	BCD 12.67 (3.1)	A 0 (0)	AB 11.48 (1.6)	AB 13.3 (15)
Stn T5.5−500	A 0 (0)	A 17.87 (2.1)	A 11.1 (10)	B 10.09 (1.6)	AB 23.3 (15)

* %Mortality value is significantly different than the control and reference sediment (Dunnett's t−test; $p<0.05$).

A Means sharing a common letter within a column are not significantly different; Tukey's HSD test for %Mortality ($p<0.05$) and planned comparisons using LSMEANS for comparing Body Weight ($p<0.01$).

TABLE 16. Summary of biological results on mayfly, midge and minnow sediment bioassays for control(s and Thunder Bay Phase II (September 1995) sediments. Mean values (+/− stand. deviation).

Test Organism	*Hexagenia limbata* (Mayfly)		*Chironomus tentans* (Midge)		*Pimephales promelas* (Fathead Minnow)
Station	*% Mortality* (N=3)	*Ave. Individual Body Weight* (mg wet wt.)	*% Mortality* (N=4)	*Ave. Individual Body Weight* (mg wet wt.)	*% Mortality* (N=3)
Control	A 0 (0)	B 7.97 (1.0)	A 16.6 (4)	AB 11.41 (0.6)	A 0 (0)
Reference	A 0 (0)	A 11.84 (0.9)	A 14.9 (14)	A 12.70 (1.1)	A 0 (0)
Stn T5.5−25	B* 50.0 (20)	B 6.67 (0.7)	B* 58.3 (16)	C 5.21 (2.0)	A 16.6 (11)
Stn T5.5−50	A 6.6 (6)	B 7.75 (0.3)	A 4.9 (6)	B 10.35 (0.7)	A 0 (0)
Stn T5.5−75	C* 100.0 (0)	–	B* 54.5 (23)	D 2.47 (0.9)	B* 73.3 (30)
Stn TEF−25	C* 100.0 (0)	–	C* 100.0 (0)	–	B* 93.3 (11)
Stn TEF−50	A 10.0 (10)	B 7.21 (0.6)	A 8.2 (3)	B 10.75 (1.3)	A 0 (0)
Stn TEF−75	A 0 (0)	B 7.55 (1.9)	A 16.6 (9)	B 12.68 (0.7)	A 0 (0)

* %Mortality value is significantly different than the control and reference sediment (Dunnett's t−test; $p<0.05$).

A Means sharing a common letter within a column are not significantly different; Tukey's HSD test for %Mortality ($p<0.05$) and planned comparisons using LSMEANS for comparing Body Weight ($p<0.01$).

TABLE 17. Test precision and discriminatory power of biological endpoints measured for Thunder Bay Phase I (July 1995) bioassays.

Endpoint	*Sample Size*	*Average of s.d.'s*	*Average of C.V.'s (%)* [a]	*Mean Maximum*	*Mean Minimum*	*Discriminatory Power* [b]
H. limbata (Mayfly)						
% Mortality	11	1.1	73	10.0	0.0	9.2
Growth	11	1.6	14	17.8	6.1	7.3
C. tentans (Midge)						
% Mortality	11	5.6	80	17.7	0.0	3.1
Growth	11	1.4	15	12.5	5.0	5.3
P. promelas (Minnow)						
% Mortality	11	16.5	56	66.6	6.6	3.6

TABLE 18. Test precision and discriminatory power of biological endpoints measured for Thunder Bay Phase II (September 1995) bioassays.

Endpoint	*Sample Size*	*Average of s.d.'s*	*Average of C.V.'s (%)* [a]	*Mean Maximum*	*Mean Minimum*	*Discriminatory Power* [b]
H. limbata (Mayfly)						
% Mortality	7	5.1	13	100	0.0	19.6
Growth	5	0.9	11	11.8	6.6	5.8
C. tentans (Midge)						
% Mortality	7	10.0	27	100	4.9	9.5
Growth	6	1.1	12	12.7	2.5	9.2
P. promelas (Minnow)						
% Mortality	7	26.1	28	93.3	0.0	12.5

a C.V.=100*Ave. s.d./Y

b DP=(Max Y−Min Y)/Ave. s.d.

TABLE 19. Association between sediment toxicity and sediment total PAH concentrations.

Station	Sediment Quality	Chemical Odour	Total PAHs (ng/g dry wt)	Mayfly Mortality	Mayfly Ave. wet wt	Midge Mortality	Midge Ave. wet wt	Minnow Mortality
Control	High	None	Not Analyzed	N	N	N	N	N
Reference	High	None	In Progress	N	N	N	N	N
Stn T5.5–200	High	None	17660	N	N	N	N	N
Stn T5.5–250	High	None	16420	N	N	N	N	N
Stn T5.5–300	High	None	10160	N	N	N	N	N
Stn T5.5–350	High	None	8200	N	N	N	N	N
Stn T5.5–400	High	None	13540	N	N	N	N	N
Stn T5.5–500	High	None	Not Available	N	N	N	N	N
Stn T5.5–175	High	Slight	29640	N	N	N	N	T
Stn T5.5–50	High	Slight	In Progress	N	T	N	N	N
Stn TEF–50	High	Slight	In Progress	N	T	N	N	N
Stn TEF–75	High	None	In Progress	N	T	N	N	N
Stn T5.5–100	Moderate	Slight	213420	N	T	N	T	N
Stn T5.5–125	Moderate	Slight	258800	N	T	N	T	N
Stn T5.5–150	Moderate	Slight	176980	N	T	N	T	T
Stn T5.5–25	Low	Moderate	In Progress	T	T	T	T	N
Stn T5.5–75	Very Low	Moderate	In Progress	T	–	T	T	T
Stn TEF–25	Very Low	Strong	In Progress	T	–	T	–	T

N – Not Toxic; T – Toxic.

Table 20: PAH Concentrations in Fathead Minnow Tissue. Phase I (July 1995). Northern Wood Preservers, Thunder Bay.
All concentrations in ng/g wet weight.

	Naphth-alene	Acenaph-thylene	Acenaph-thene	Fluorene	Phenan-threne	Anthra-cene	Fluoren-thene	Pyrene	Benzo[e] anthracene
Control 1	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W
Control 2	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W
T 5.5-100m	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W
T 5.5-100m	40<T	20<W	20<W	20<W	20<W	20<W	80<T	100	60<T
T 5.5-125m	20<W	20<W	20<W	20<W	100	20<W	80<T	80<T	20<W
T 5.5-125m	20<W	20<W	20<W	20<W	60<T	20<W	40<T	40<T	20<W
T 5.5-150m	20<W	20<W	20<W	20<W	40<T	20<W	140	100	100
T 5.5-175m	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W
T 5.5-200m	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W
T 5.5-200m	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W
T 5.5-250m	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W
T 5.5-300m	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W
T 5.5-350m	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W
T 5.5-350m	20<W	20<W	20<W	20<W	40<T	20<W	20<W	40<T	20<W
T 5.5-400m	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W
T 5.5-400m	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W
T 5.5-500m	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W
T 5.5-500m	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W	20<W

	Chrysene	Benzo[b] fluoran-thene	Benzo[k] fluoran-thene	Benzo[a] pyrene	Benzo [g,h,i] perylene	Dibenzo [a,h]an-thracene	Indeno [123-cd] pyrene	Totel PAH
Control 1	20<W	20<W	20<W	40<W	40<W	40<W	40<W	<W
Control 2	20<W	20<W	20<W	40<W	40<W	40<W	40<W	<W
T 5.5-100m	20<W	20<W	20<W	40<W	40<W	40<W	40<W	<W
T 5.5-100m	60<T	80<T	40<T	40<W	40<W	40<W	40<W	460
T 5.5-125m	40<T	40<T	20<W	40<W	40<W	40<W	40<W	340
T 5.5-125m	40<T	60<T	20<W	40<W	40<W	40<W	40<W	240
T 5.5-150m	140	200	140	80<T	120<T	40<W	120<T	1180
T 5.5-175m	20<W	40<T	20<W	40<W	40<W	40<W	40<W	40
T 5.5-200m	20<W	20<W	20<W	40<W	40<W	40<W	40<W	<W
T 5.5-200m	20<W	20<W	20<W	40<W	40<W	40<W	40<W	<W
T 5.5-250m	20<W	40<T	20<W	40<W	40<W	40<W	40<W	40
T 5.5-300m	20<W	20<W	20<W	40<W	40<W	40<W	40<W	<W
T 5.5-350m	20<W	20<W	20<W	40<W	40<W	40<W	40<W	<W
T 5.5-350m	20<W	20<W	20<W	40<W	40<W	40<W	40<W	80
T 5.5-400m	20<W	20<W	20<W	40<W	40<W	40<W	40<W	<W
T 5.5-400m	20<W	20<W	20<W	40<W	40<W	40<W	40<W	<W
T 5.5-500m	20<W	20<W	20<W	40<W	40<W	40<W	40<W	<W
T 5.5-500m	20<W	20<W	20<W	40<W	40<W	40<W	40<W	<W

<W = delow detection limit <T = trace amount

TABLE 21. Mean total PAH concentrations in fathead minnows (P. promelas) exposed to control(s) and Thunder Bay Phase I sediments in the laboratory (ng/g, dry weight). Values reported as mean +/− standard deviation. Sample size N=2 unless otherwise indicated.

Station	Minnow total PAH concentration ng/g dry weight	Sediment total PAH concentration ng/g dry weight
Pre−exposure	2680 (−) <W [a]	N/A
Control	2680 (0) <W	N/A
Reference	2680 (0) <W	N/A
Stn T5.5−100	3750 (1513) <T	213420
Stn T5.5−125	3953 (473) <T	258800
Stn T5.5−150	8844 (−) [a]	176980
Stn T5.5−175	2814 (−) <W [a]	29640
Stn T5.5−200	2680 (0) <W	17660
Stn T5.5−250	2814 (−) <W [a]	16420
Stn T5.5−300	2680 (−) <W [a]	10160
Stn T5.5−350	2814 (189) <W	8200
Stn T5.5−400	2680 (0) <W	13540
Stn T5.5−500	2680 (0) <W	N/A

a Sample size N=1;

<W − Not Detected; <T − Trace amount.

N/A − Not Available.

Figures

Figure 1 : Location of Control Stations and Sampling Transects
Northern Wood Preservers - Thunder Bay, July 1995

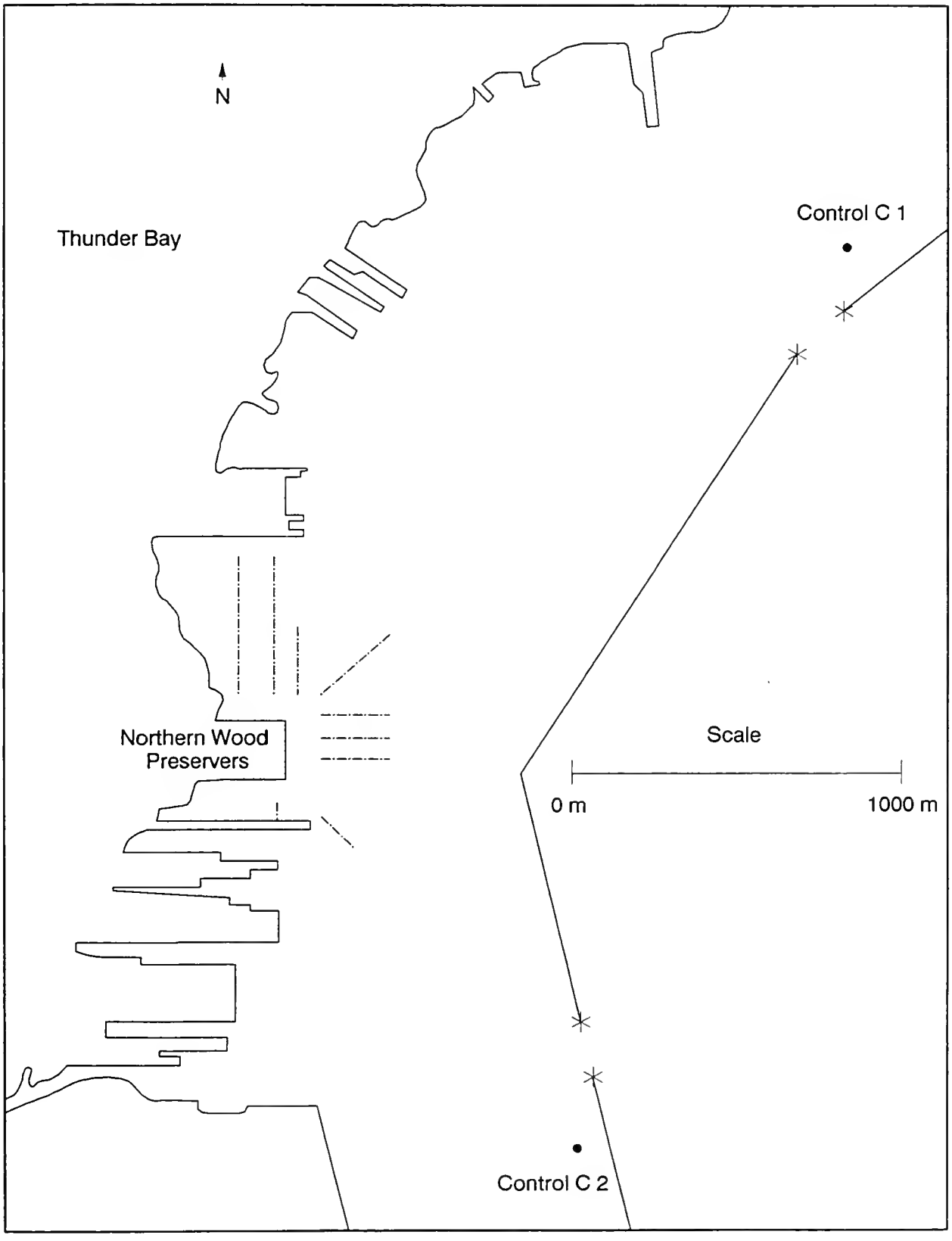

Figure 2: Location of Sediment Sampling Stations, July 1995
Surficial Grab Samples (Ponar)

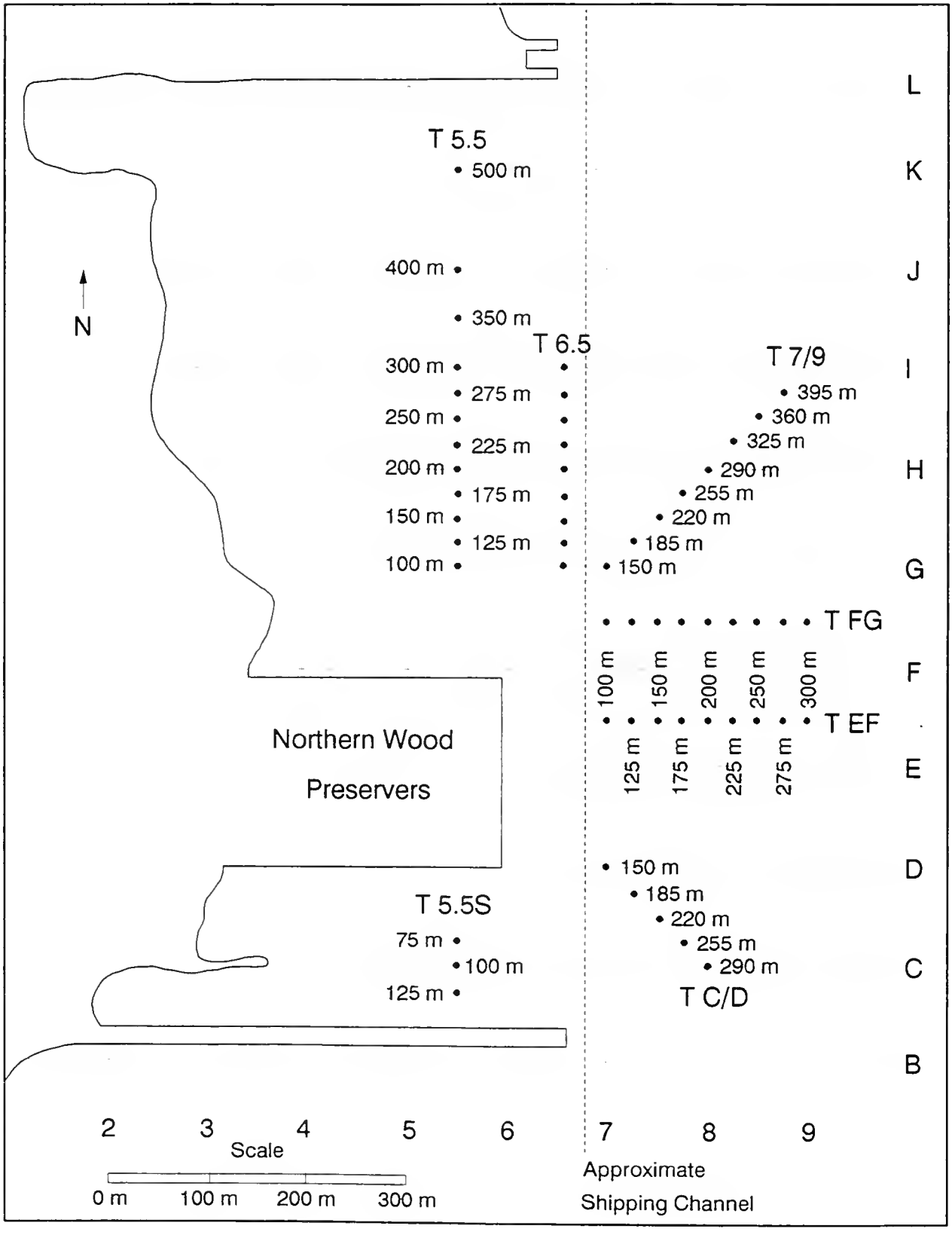

Figure 3: Location of Sediment Core Sampling Stations, July 1995

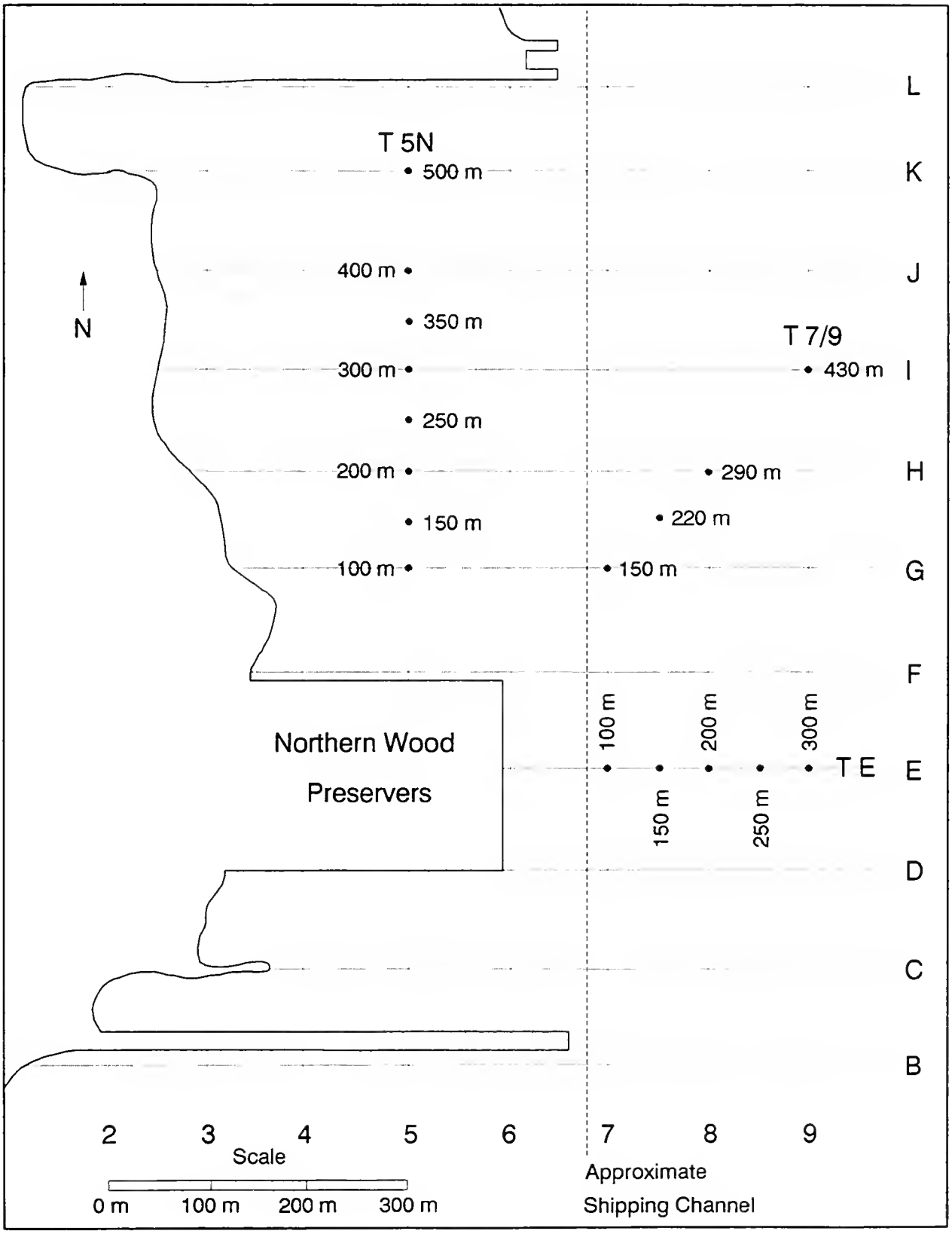

Figure 4: Location of Benthic Community Sampling Stations, July 1995

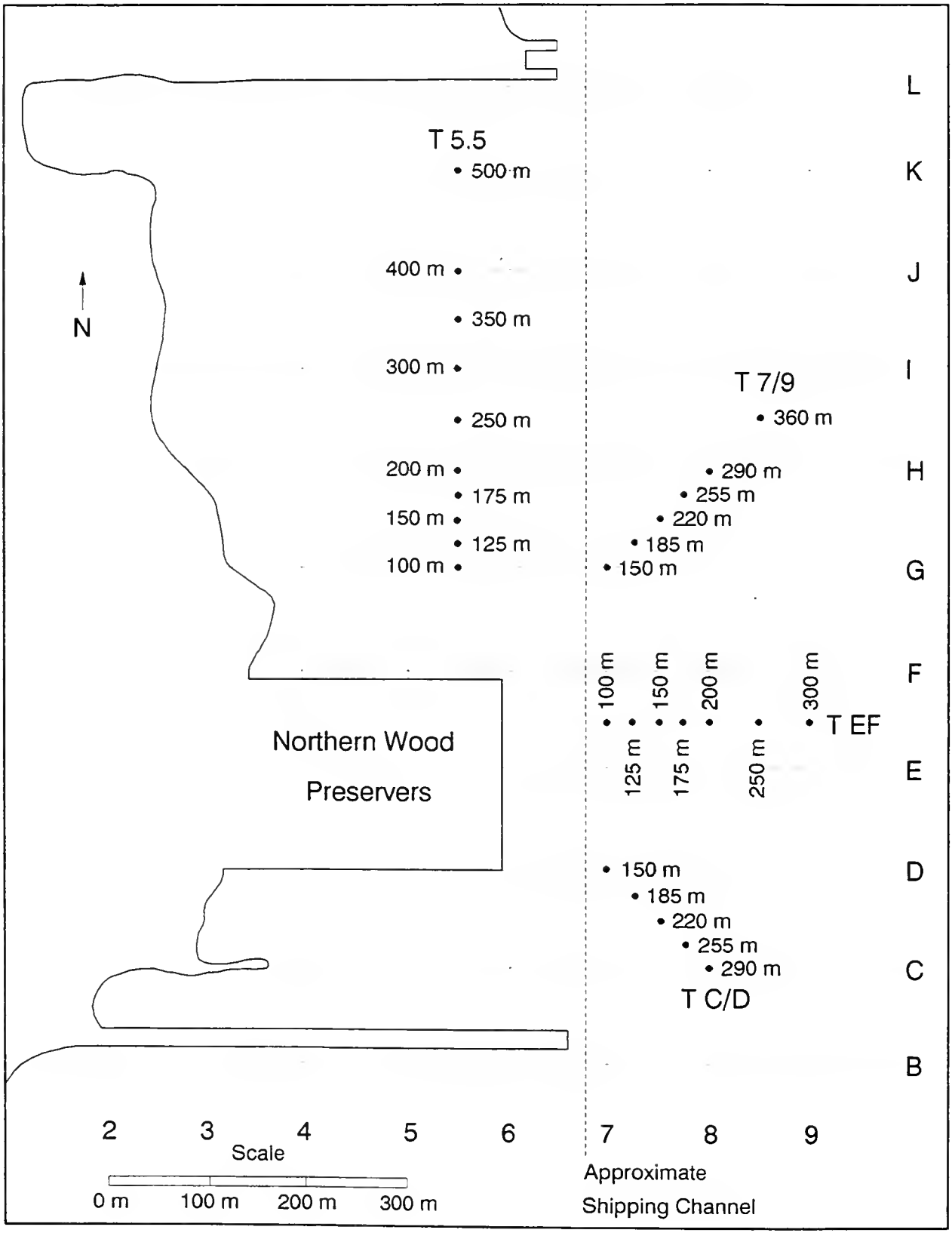

Figure 5: Sediment Bioassay Sample Locations, July and September 1995

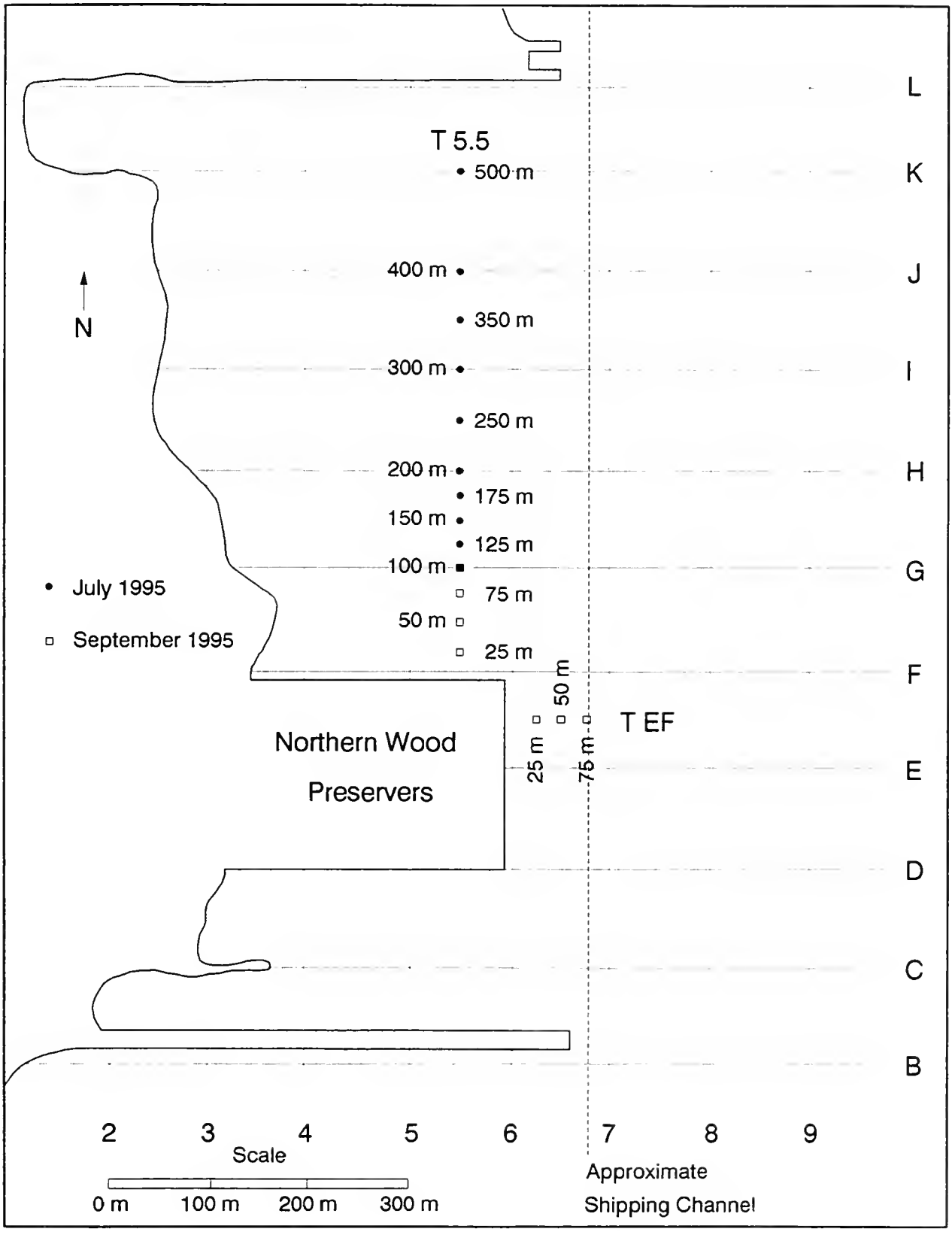

Figure 6: Surficial Sediment Sampling Locations, September 1995

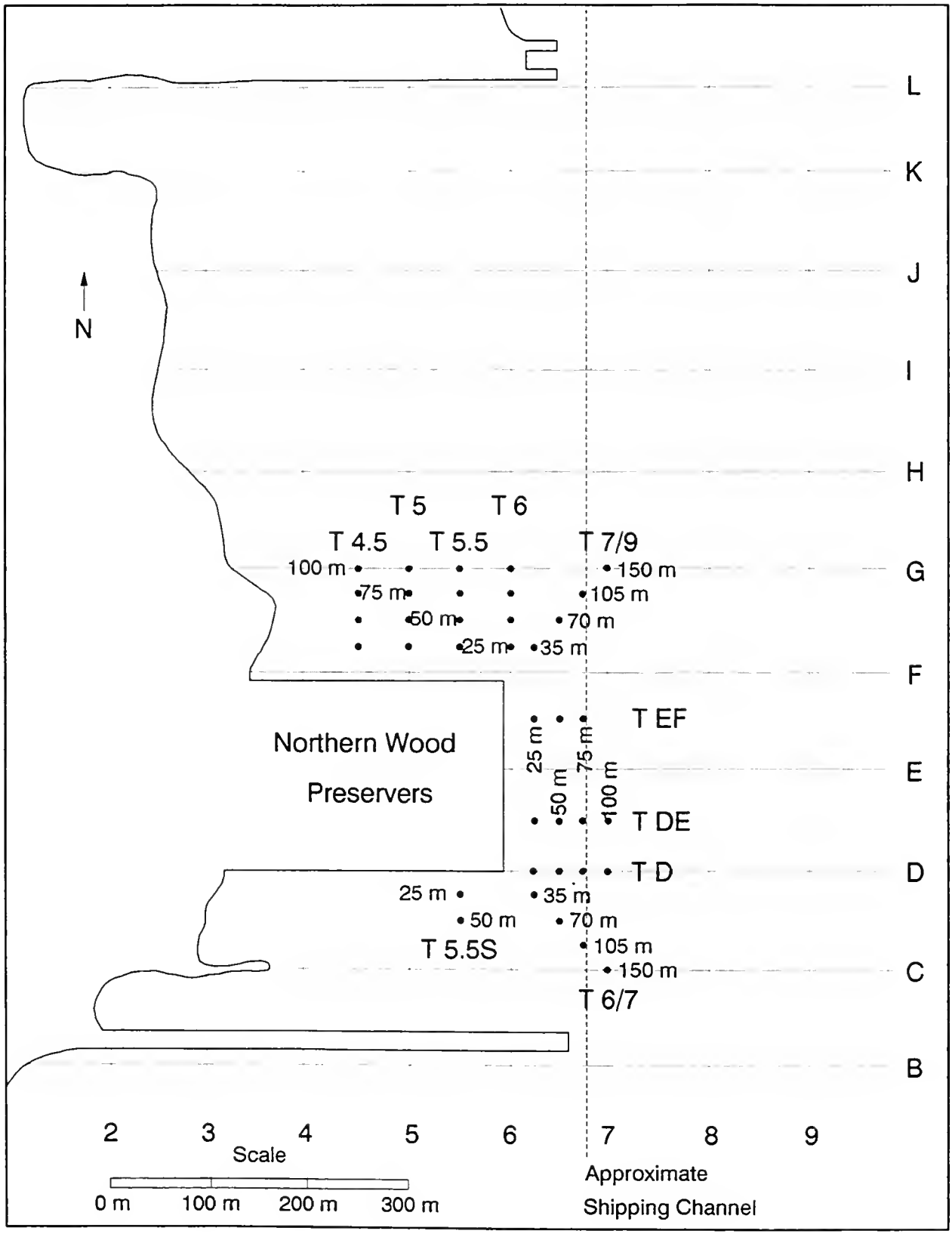

Figure 7: Benthic Community Sampling Locations, September 1995

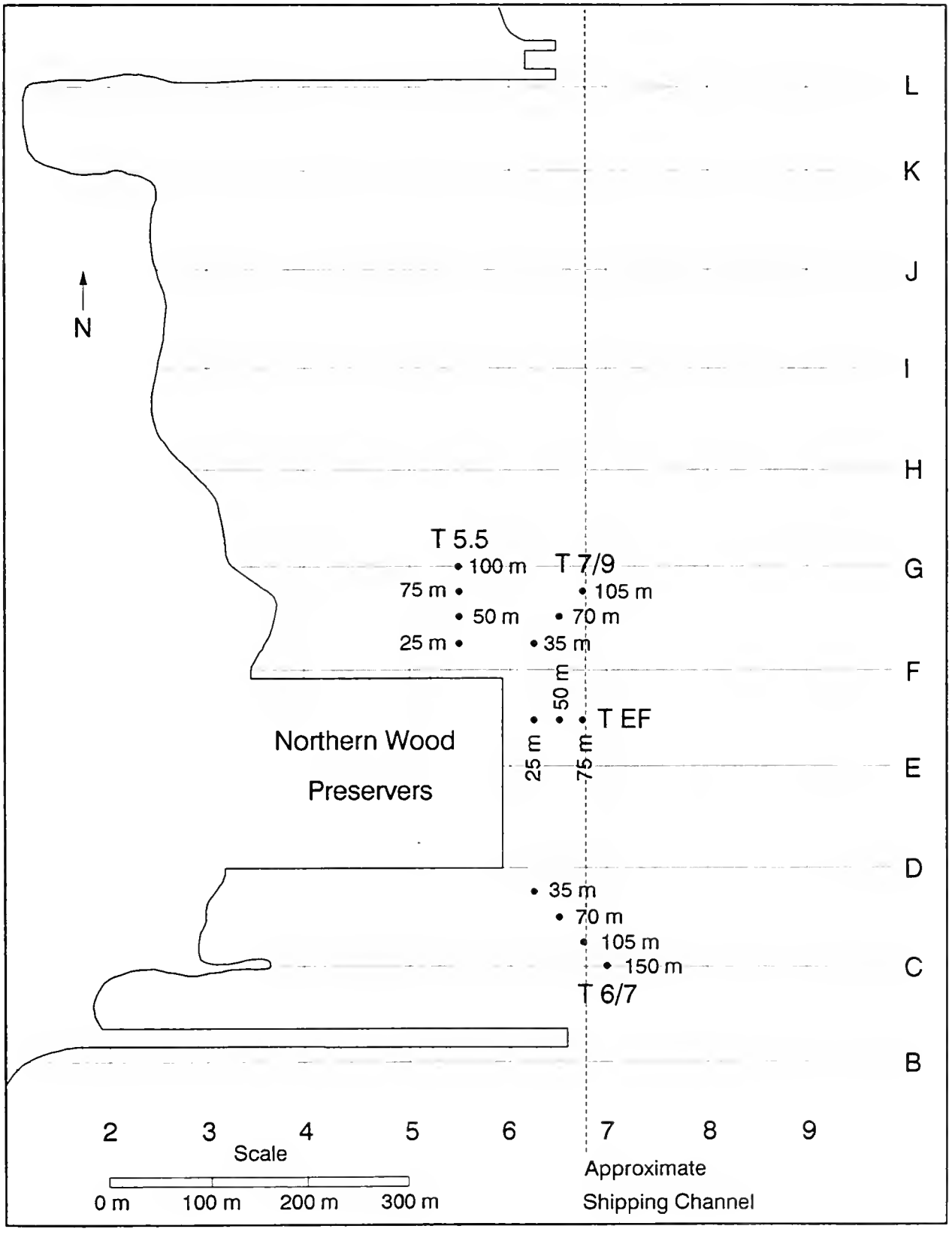

Figure 8a: Sediment Total PAH - All Sites

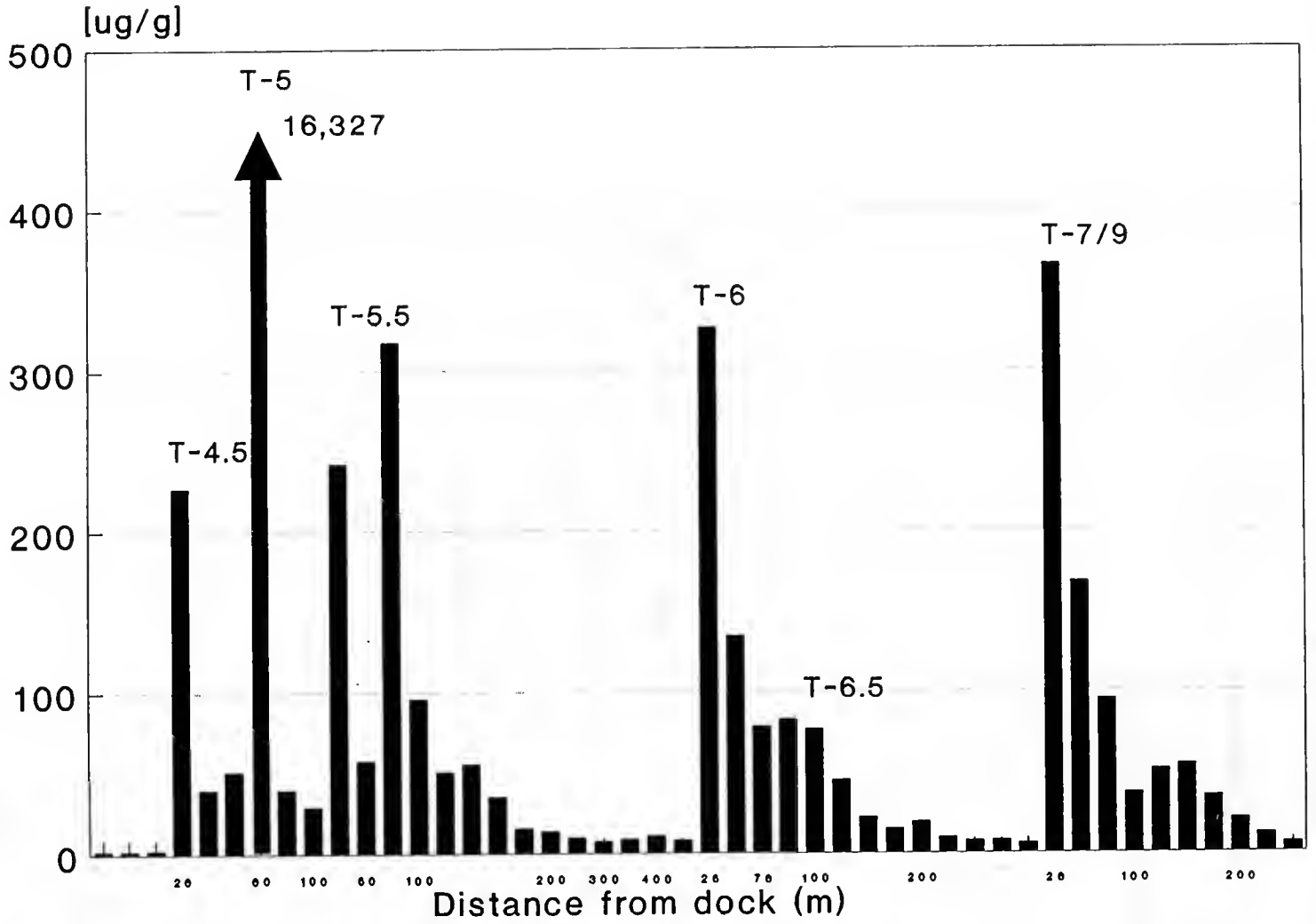

Figure 8b: Sediment Total PAH - All Sites

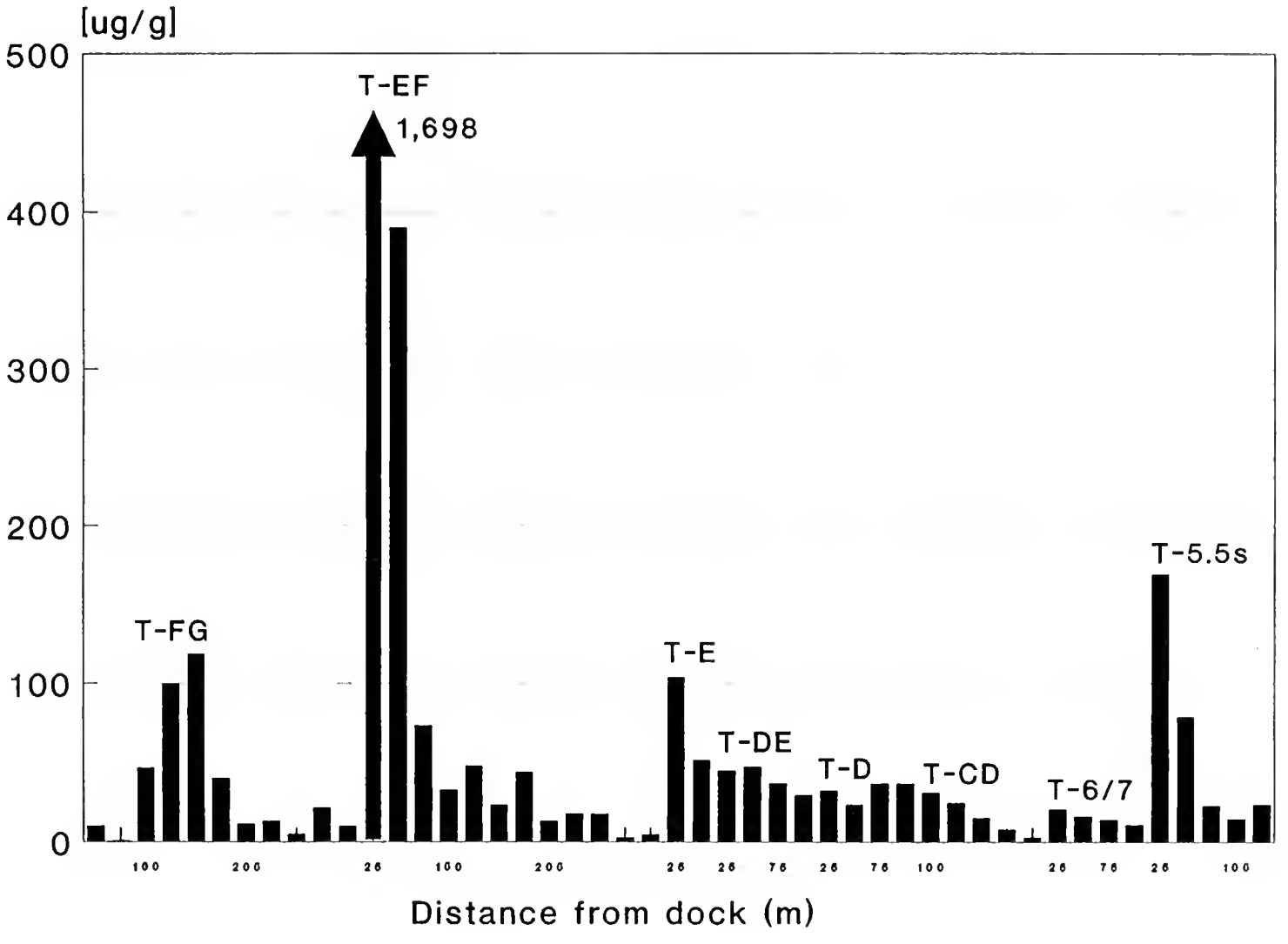

Figure 9a: Sediment Total PAH in 100m Zone

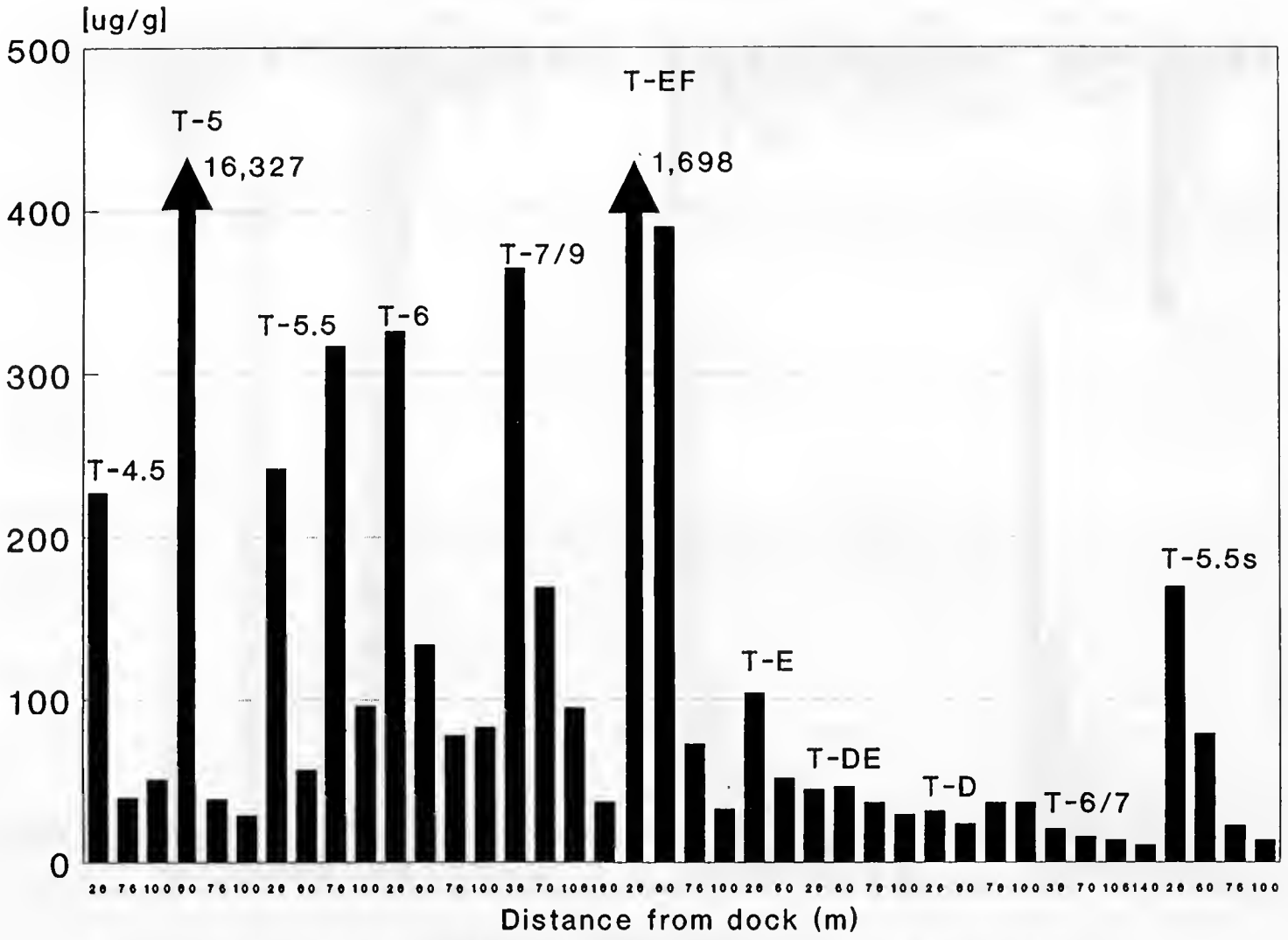

Figure 9b: Total PAH in Sediment Beyond 100m Zone

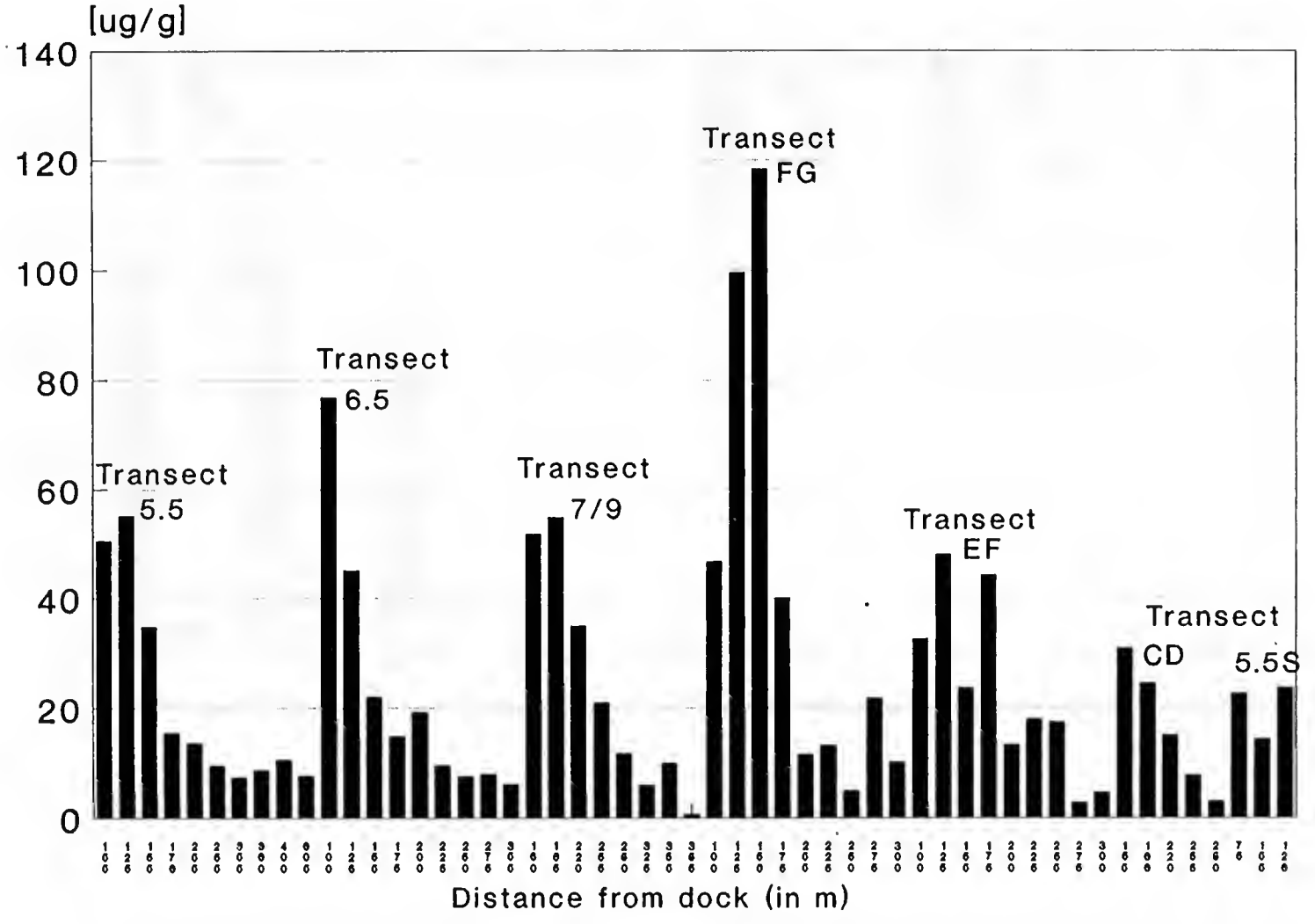

Figure 10: Total PAH in Sediment Cores 1988-1995

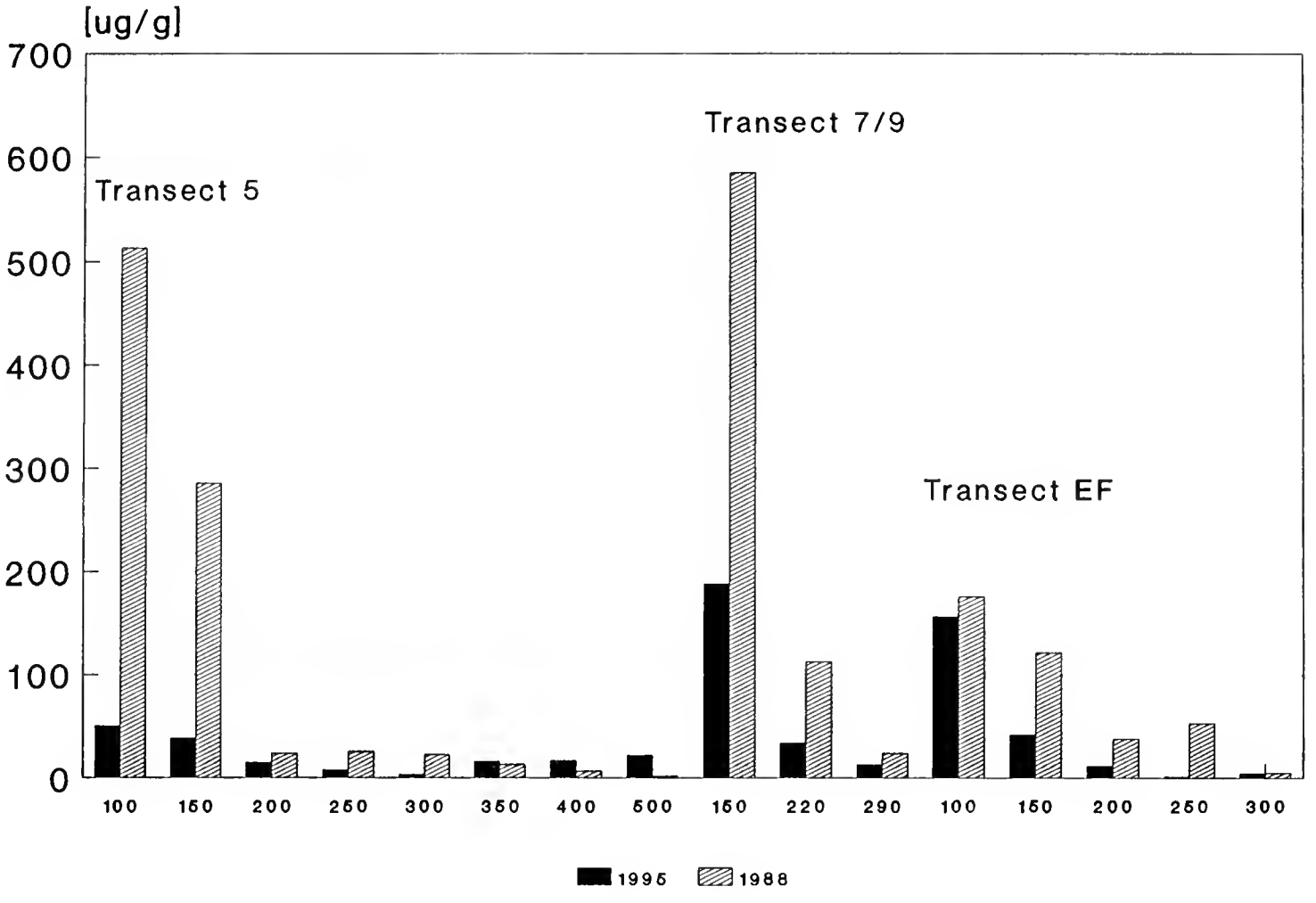

Figure 11: Total PAH in Bioassay Sediments and Surficial Sediments

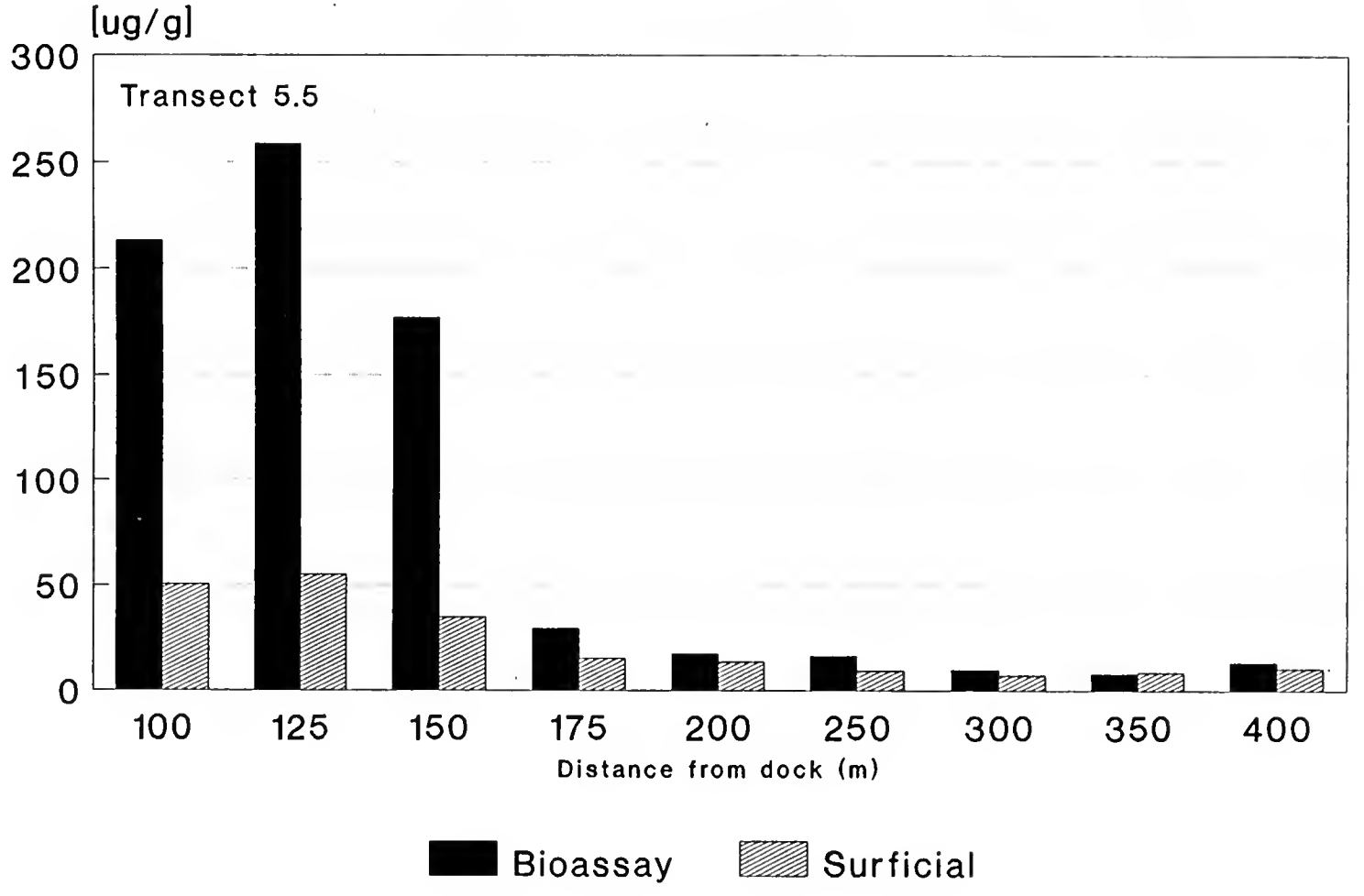

Figure 12: Pentachlorophenol in Surficial Sediments

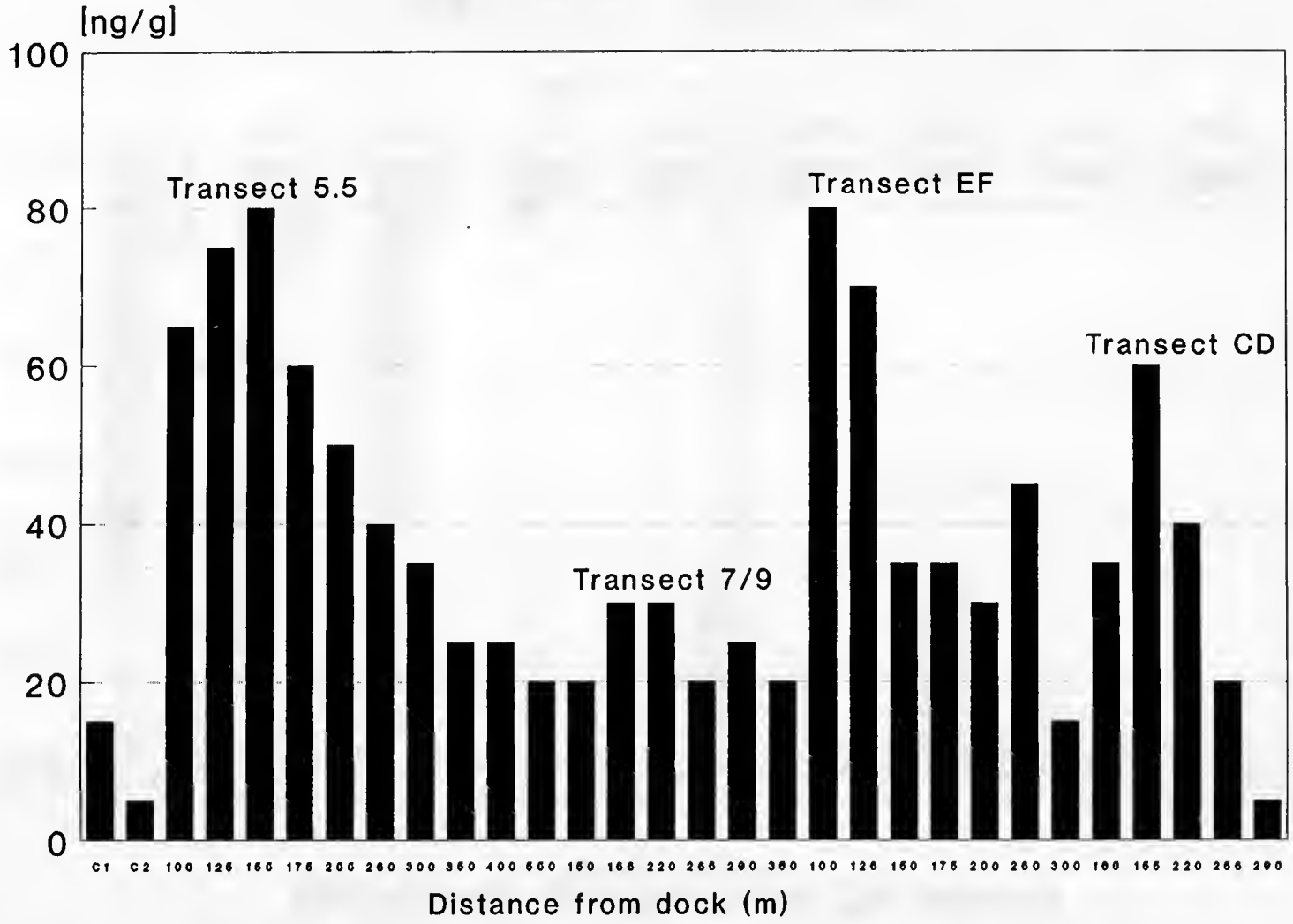

Figure 13: Dioxins and Furans in Sediment
July & September 1995

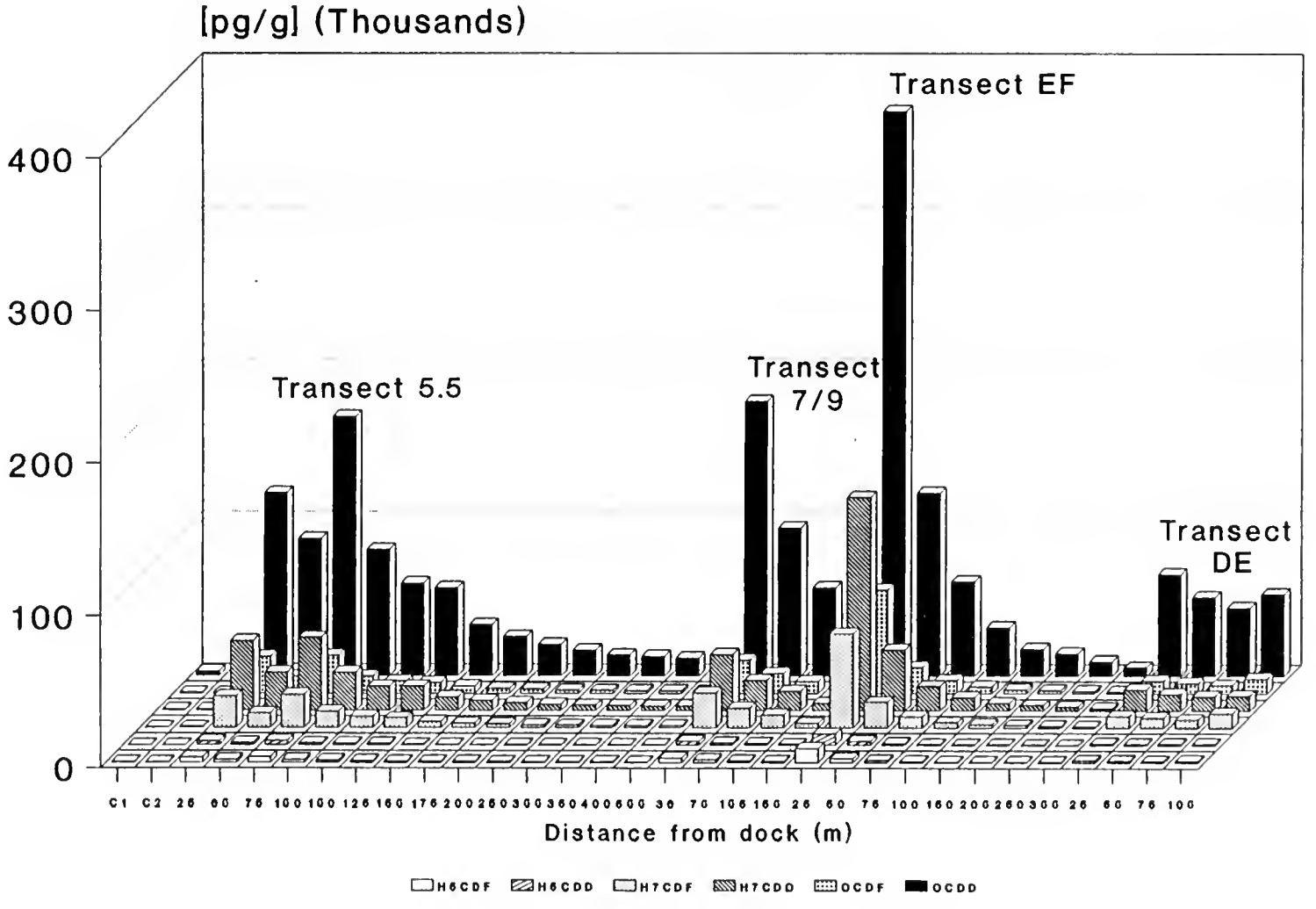

Figure 14: Dioxin and Furan Total TEQ
Phase I and Phase II

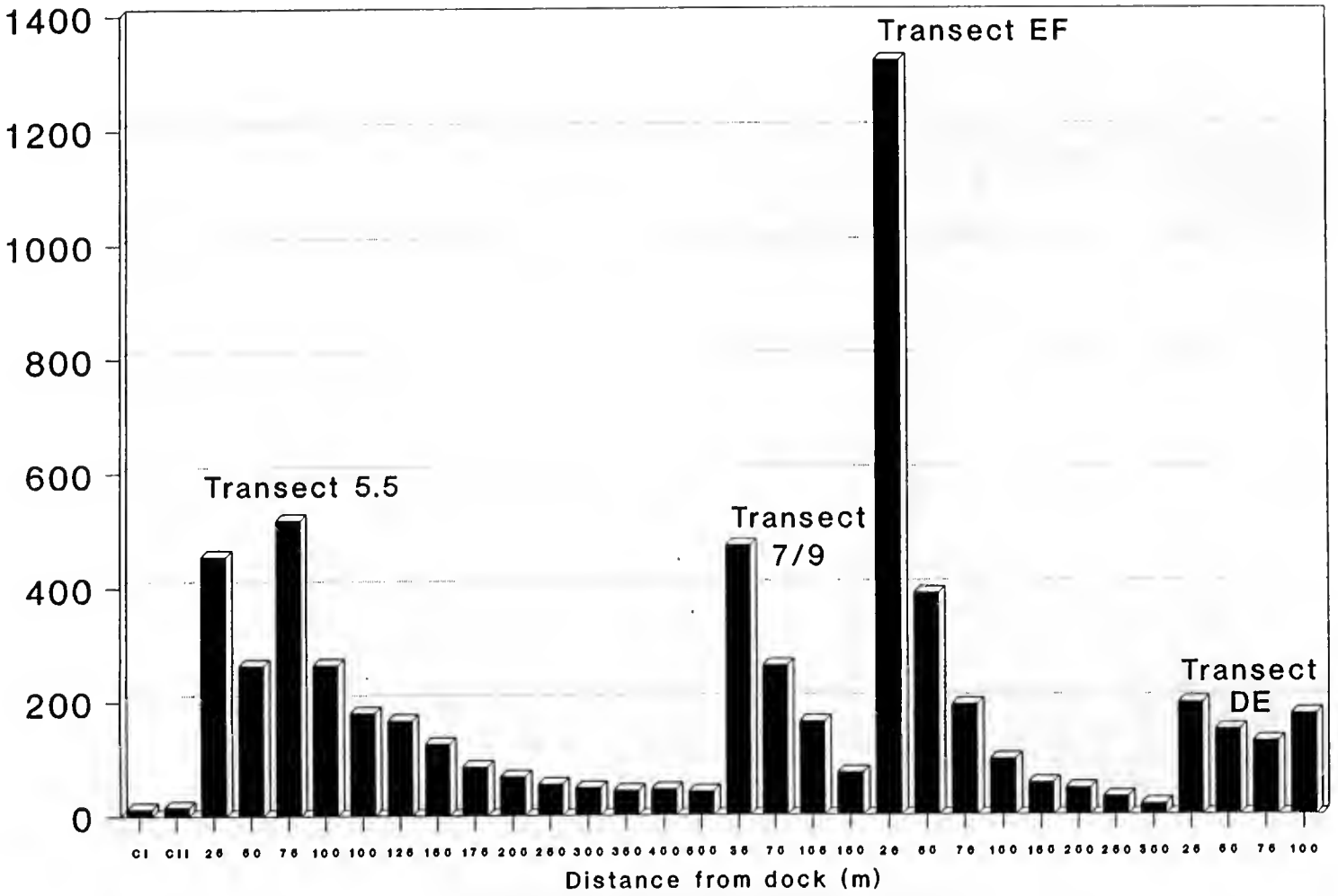

Figure 15: Distribution of Major Taxonomic Groups Phase I

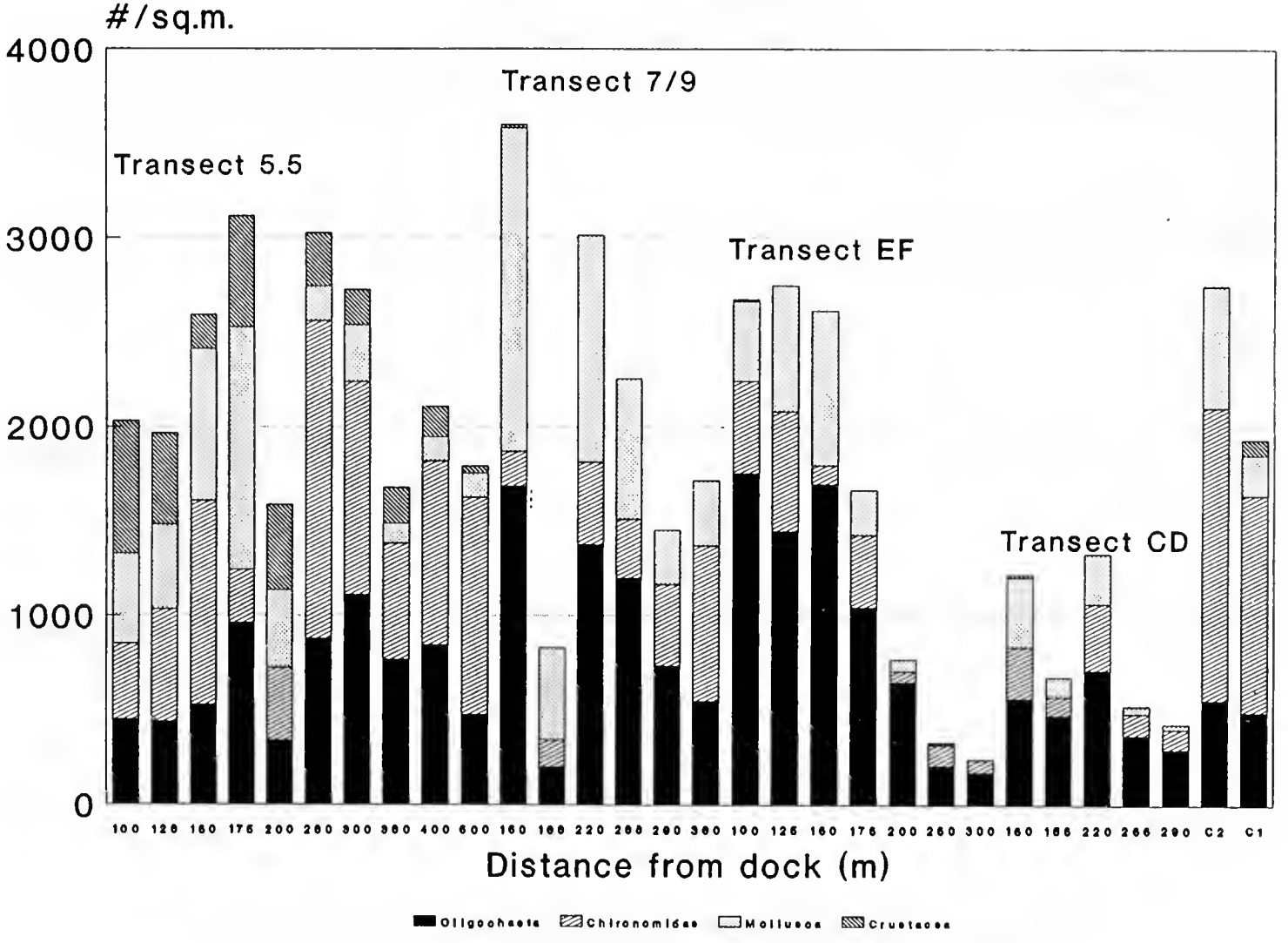

Figure 16: Distribution of Sediment Total PAH and Benthic Organisms, Phase I

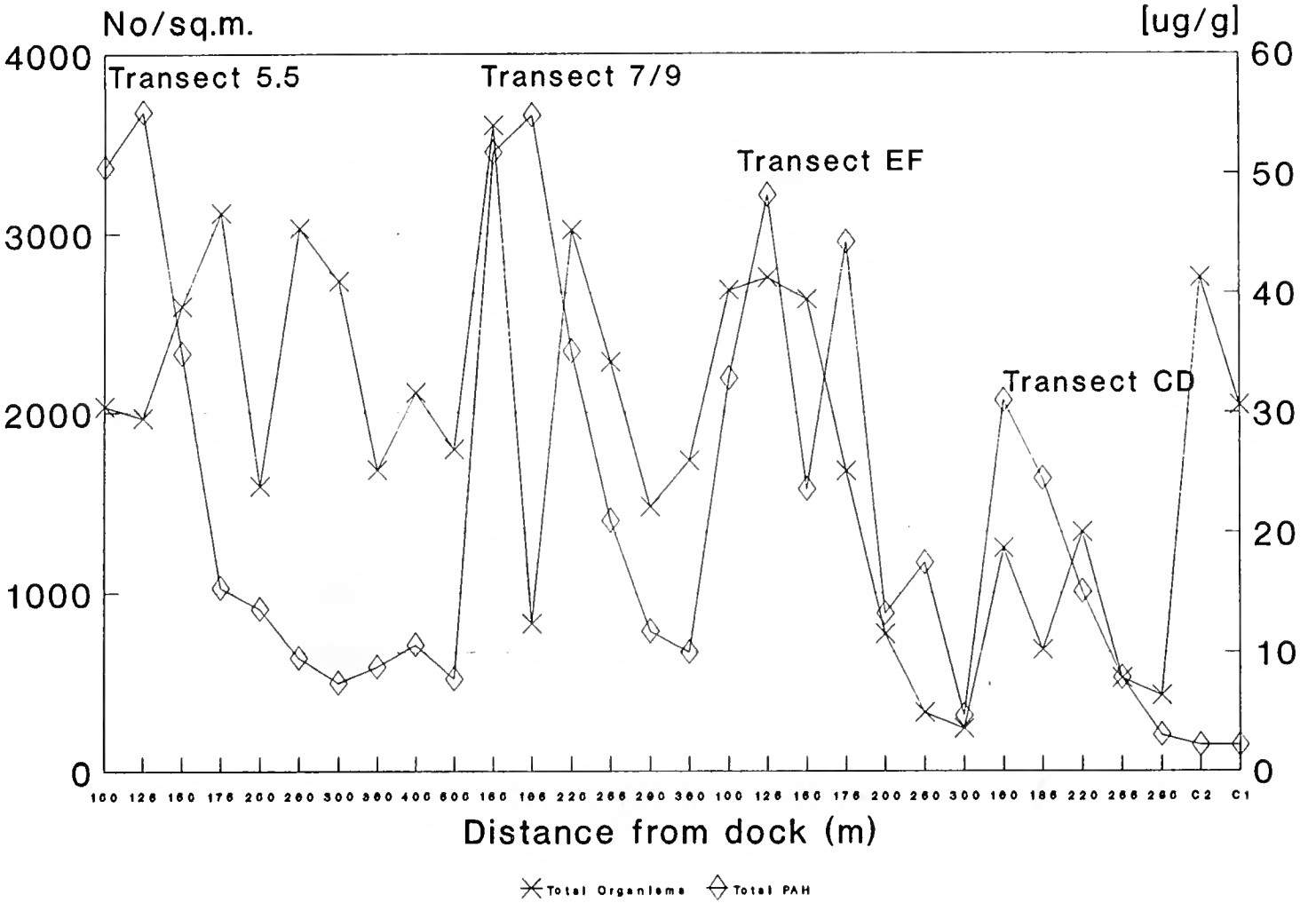

Figure 17: Chironomid Density and Total PAH, Phase I

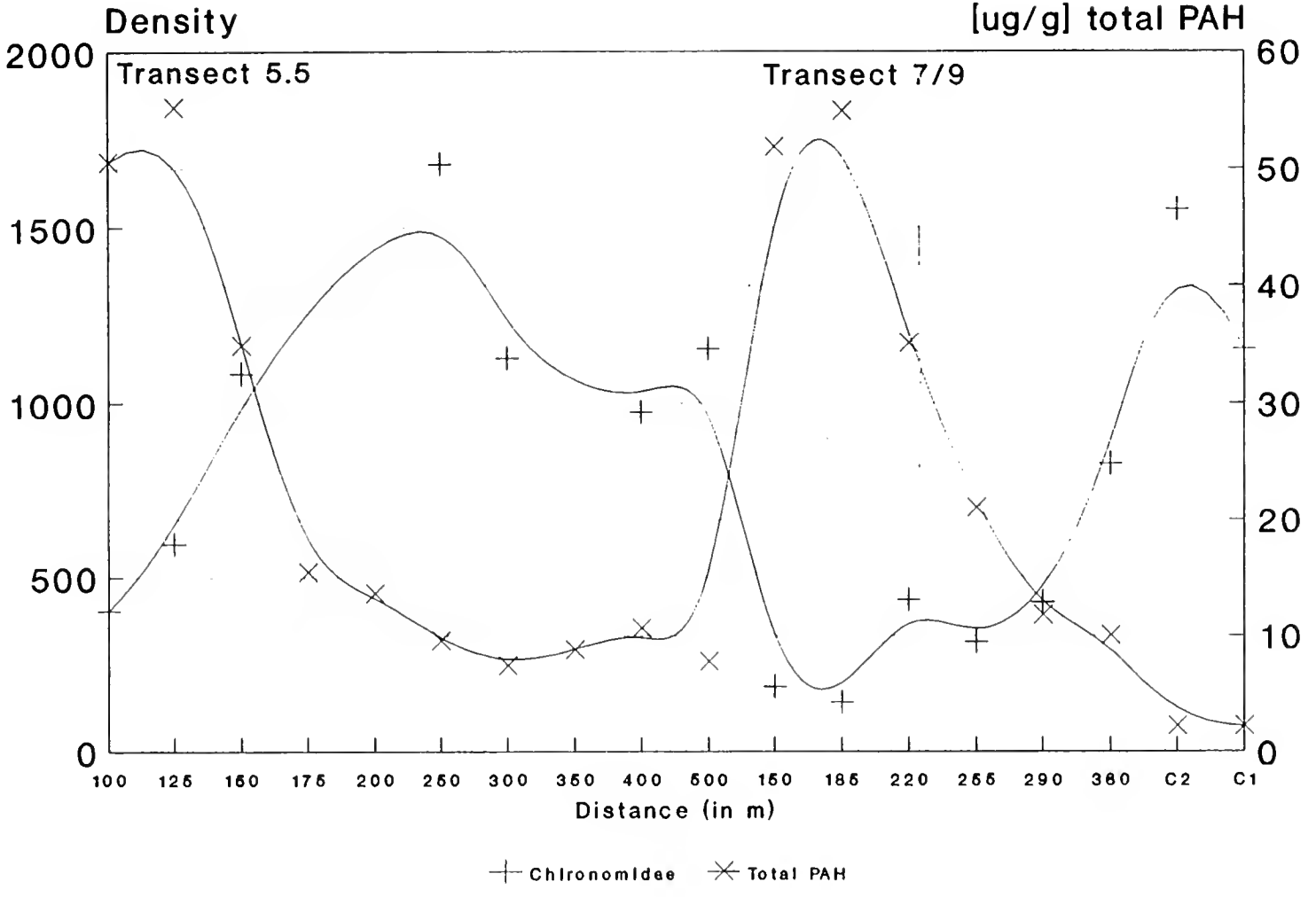

Figure 18: Distribution of Benthic Taxa - Phase II

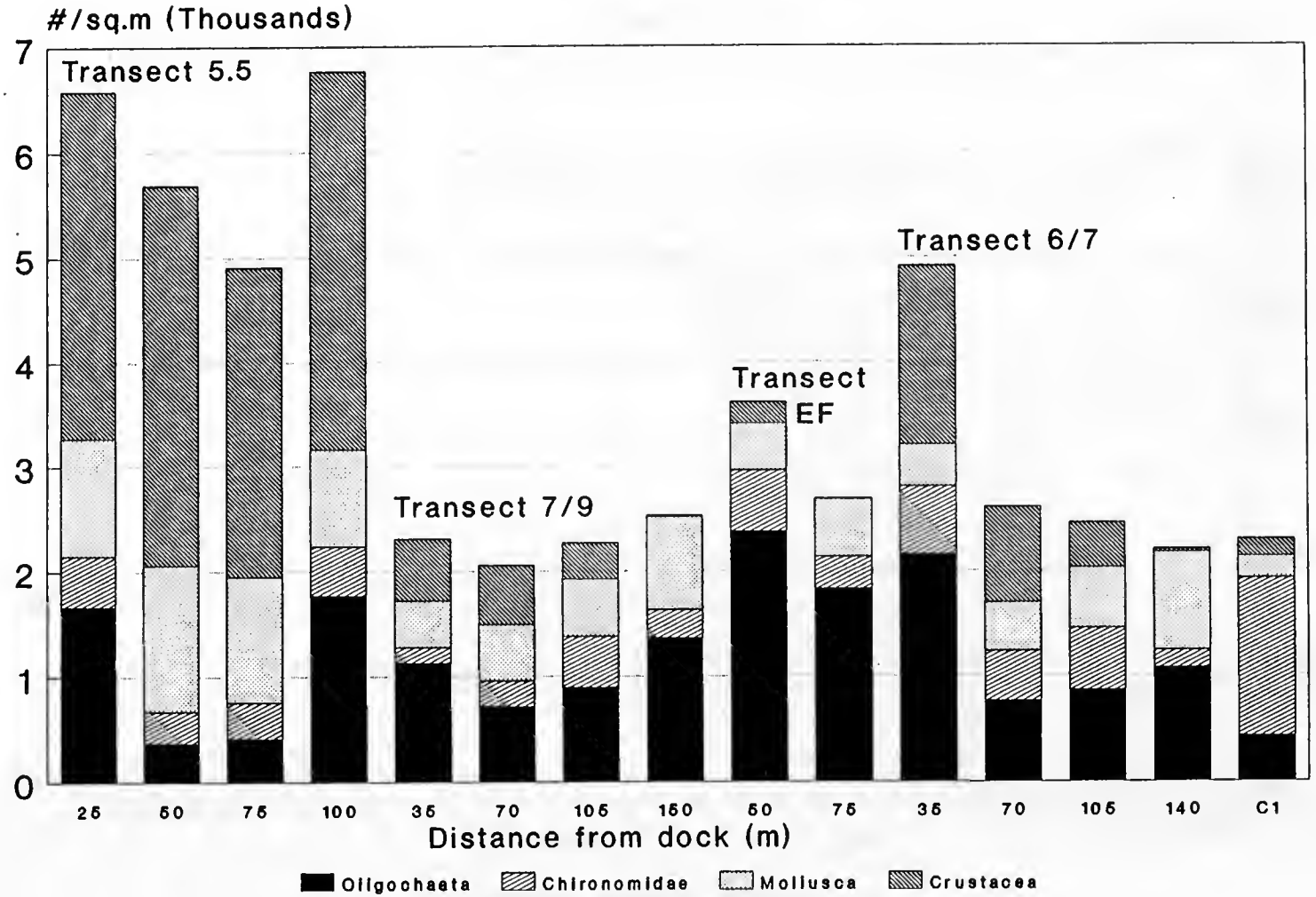

Figure 19: Distribution of Major Taxonomic Groups Phase I and II

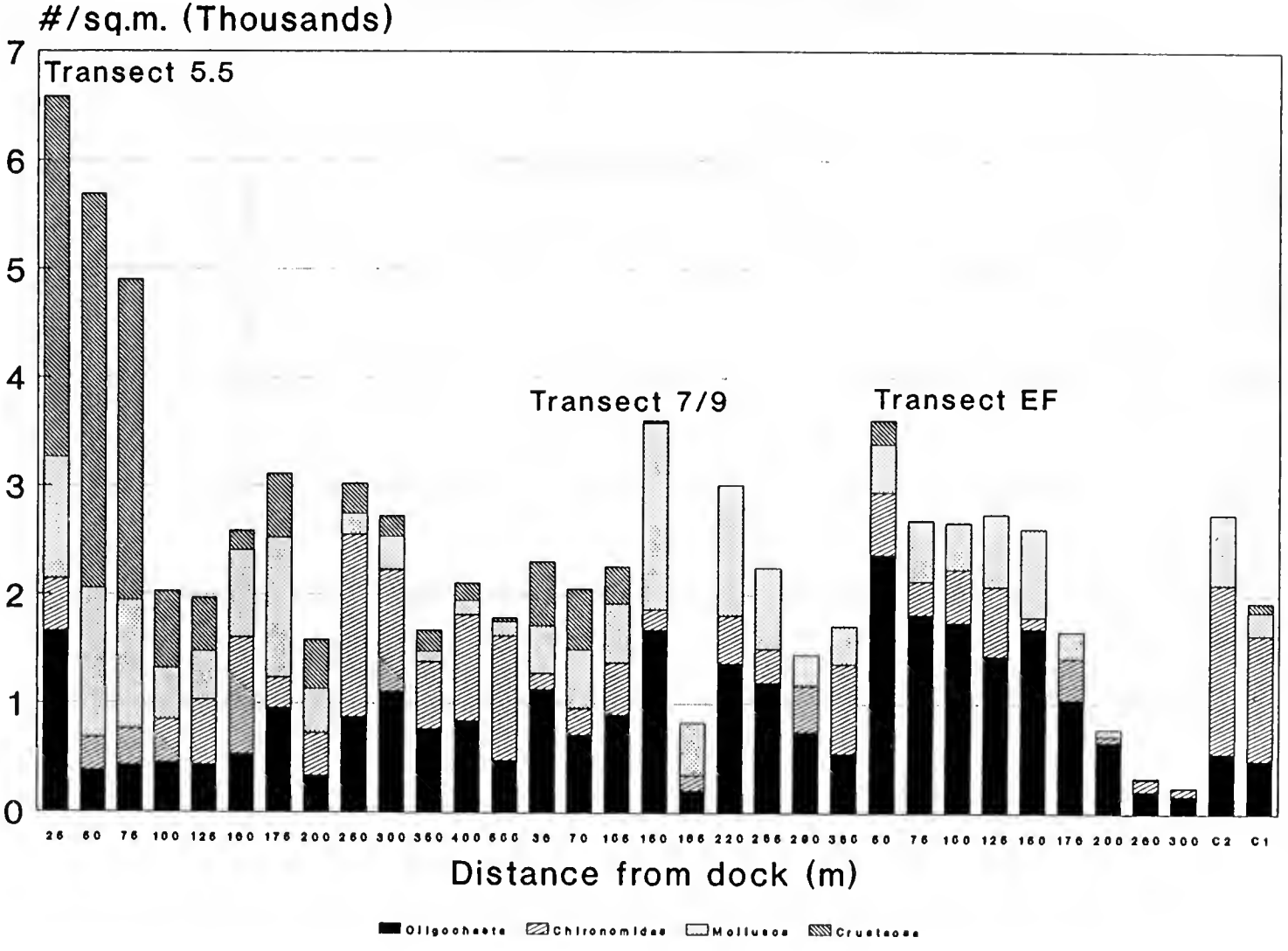

Figure 20: Regression of Chironomid Density on Sediment Total PAH

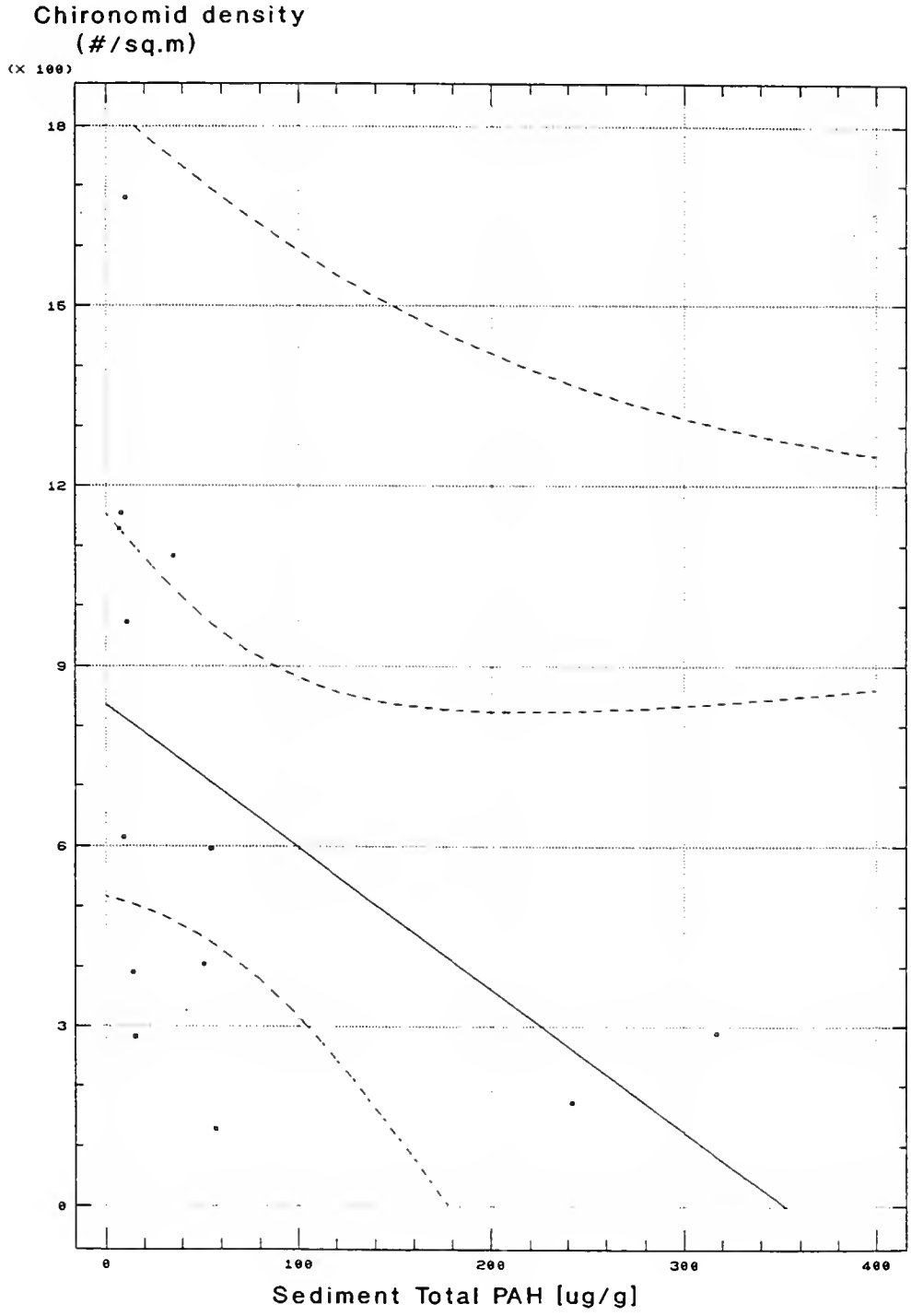

Figure 21: Chironomid and Mayfly Mortality, Phase I and Phase II

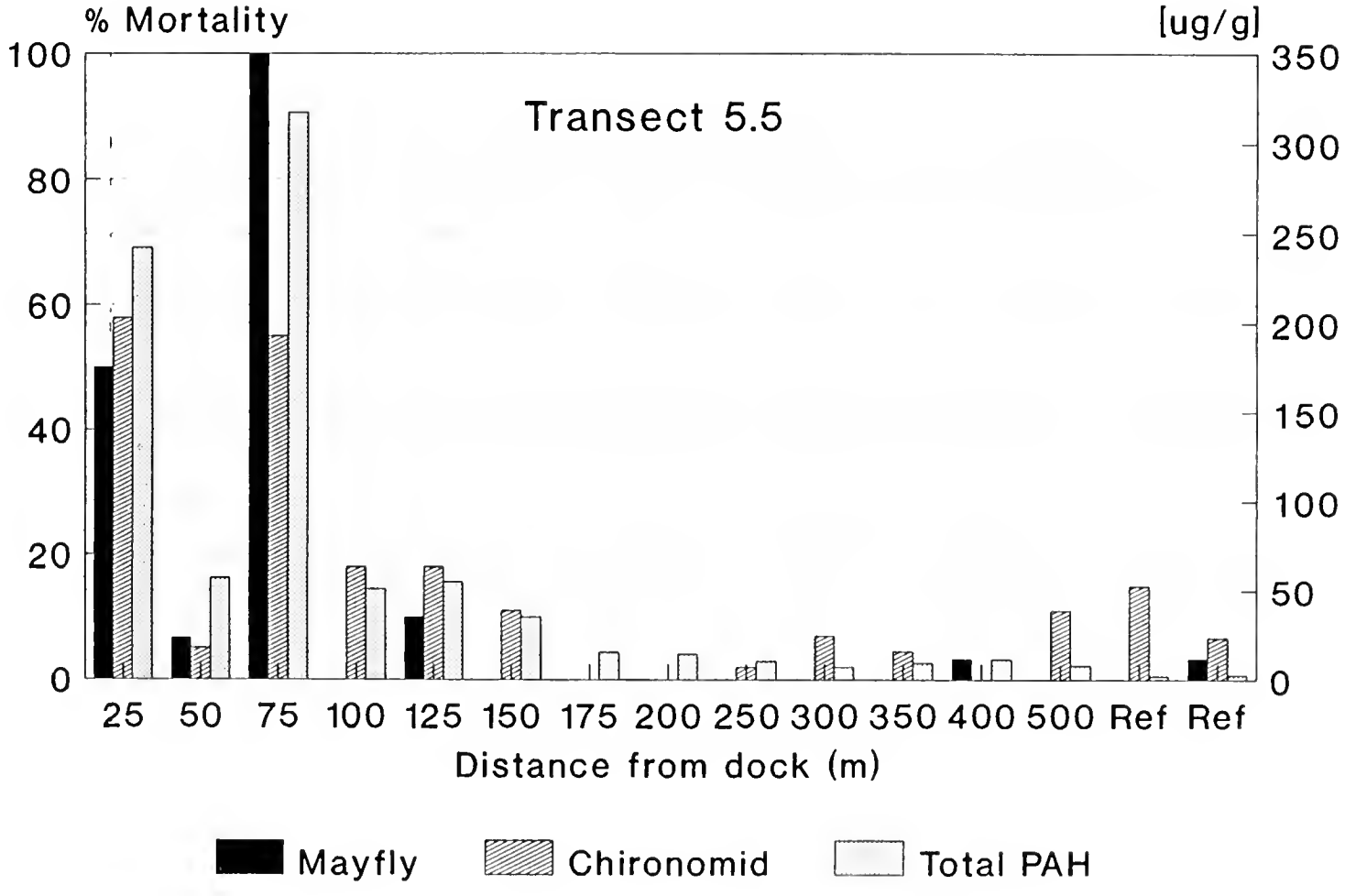

Figure 22: Chironomid and Mayfly Mortality, Phase II.

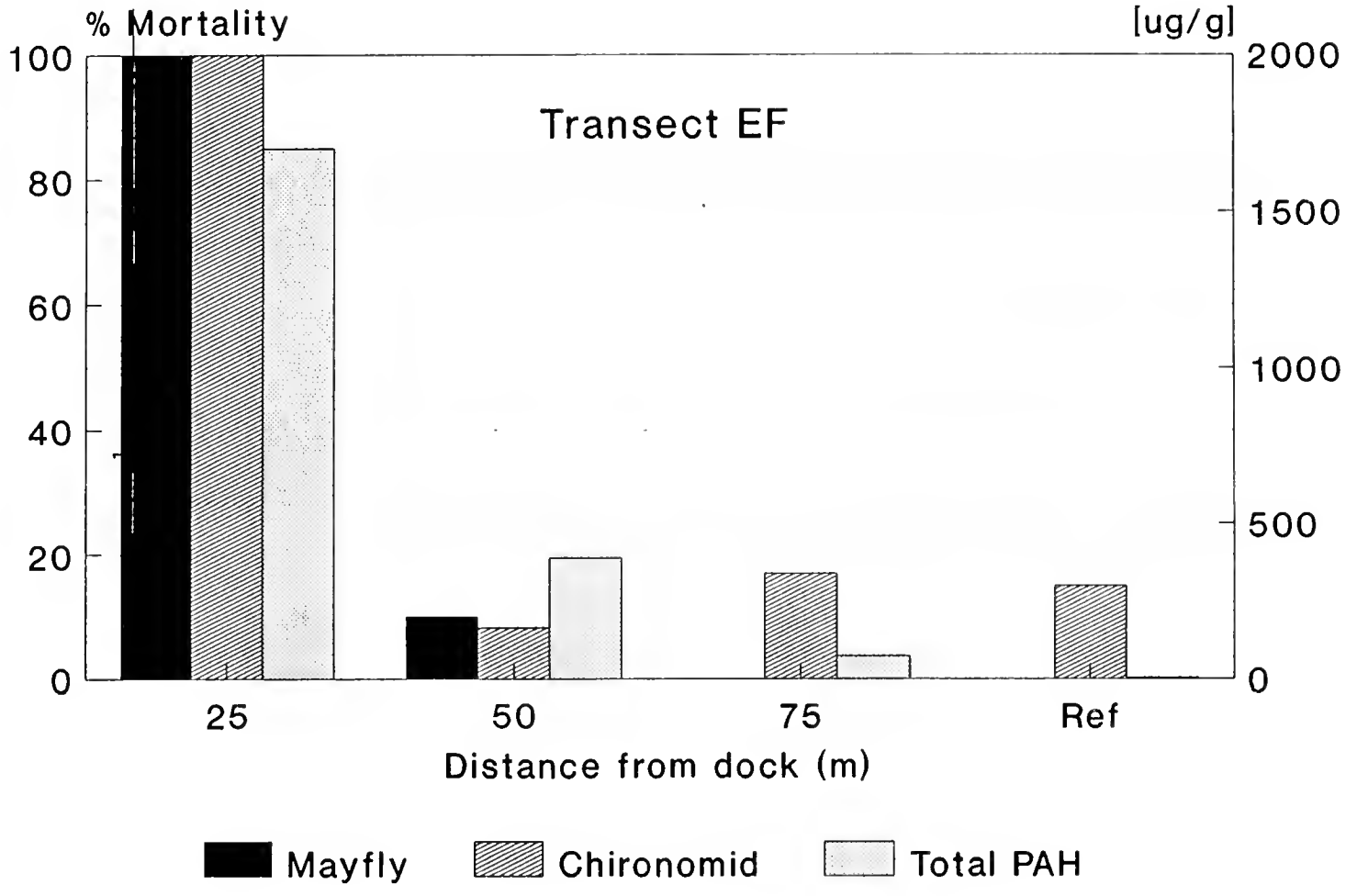

Figure 23: Mayfly and Chironomid Growth Phase I and Phase II

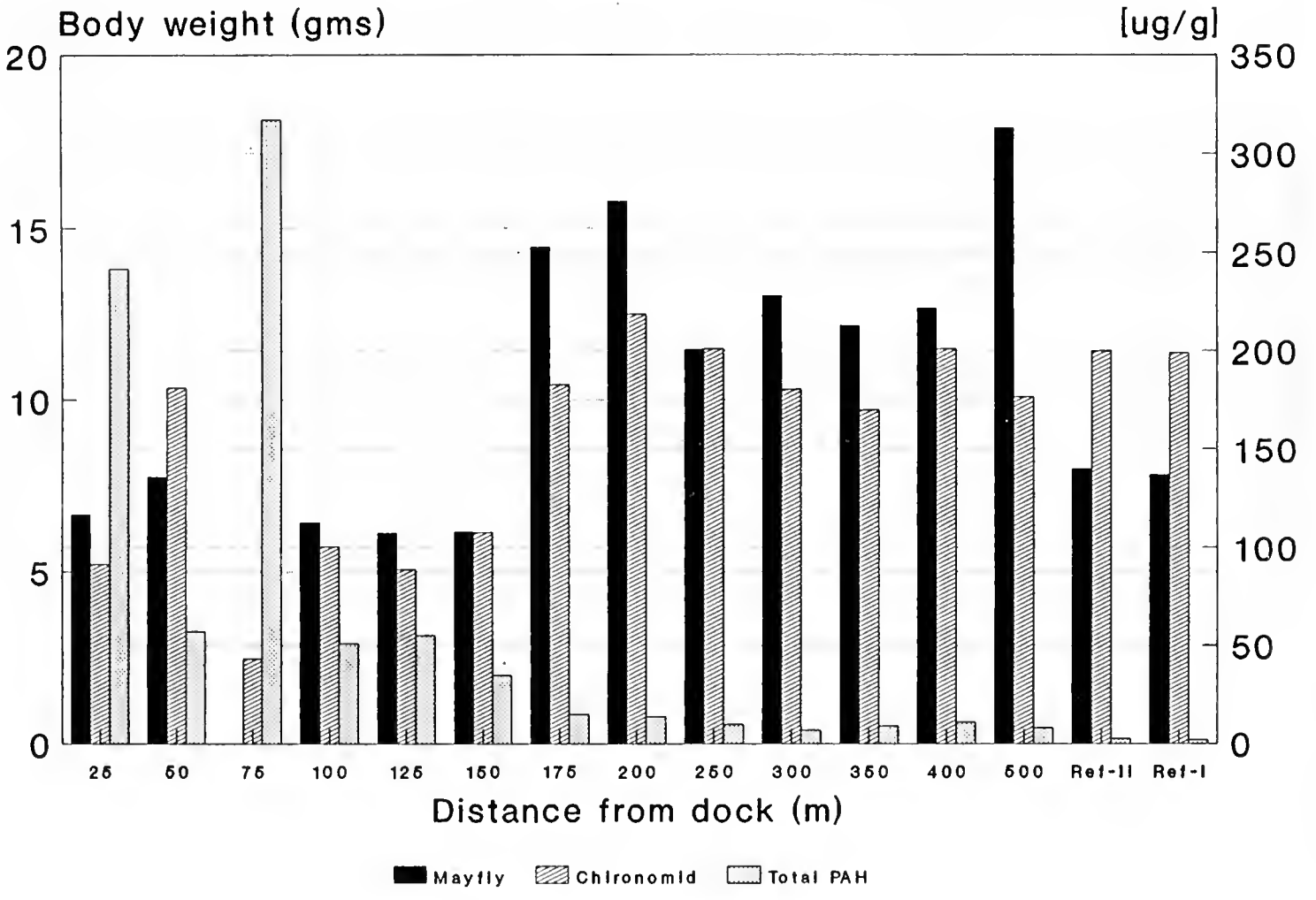

Figure 24: Regression of Mayfly Mortality on Sediment Total PAH

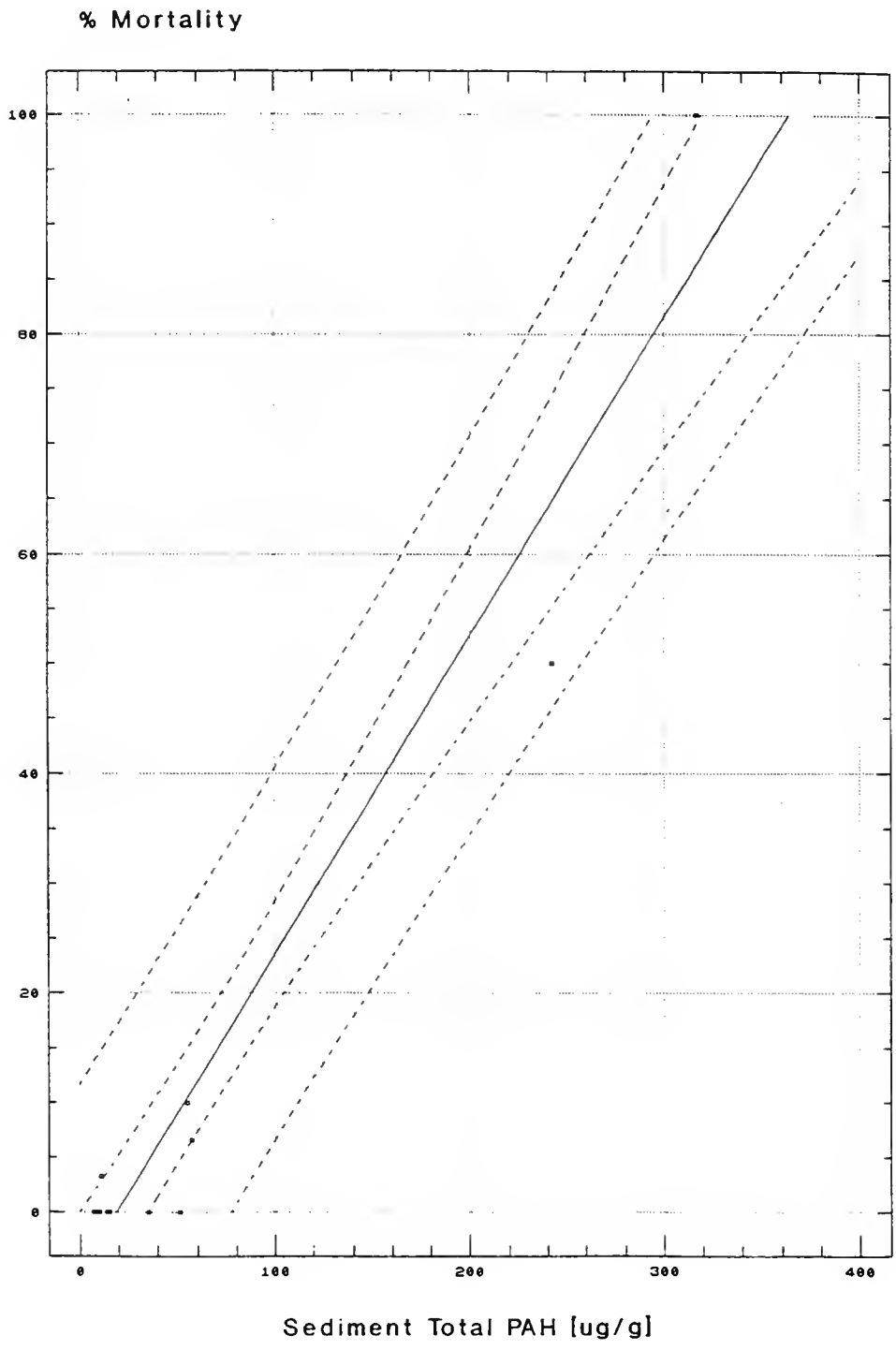

Figure 25: Regression of Chironomid Mortality on Sediment Total PAH

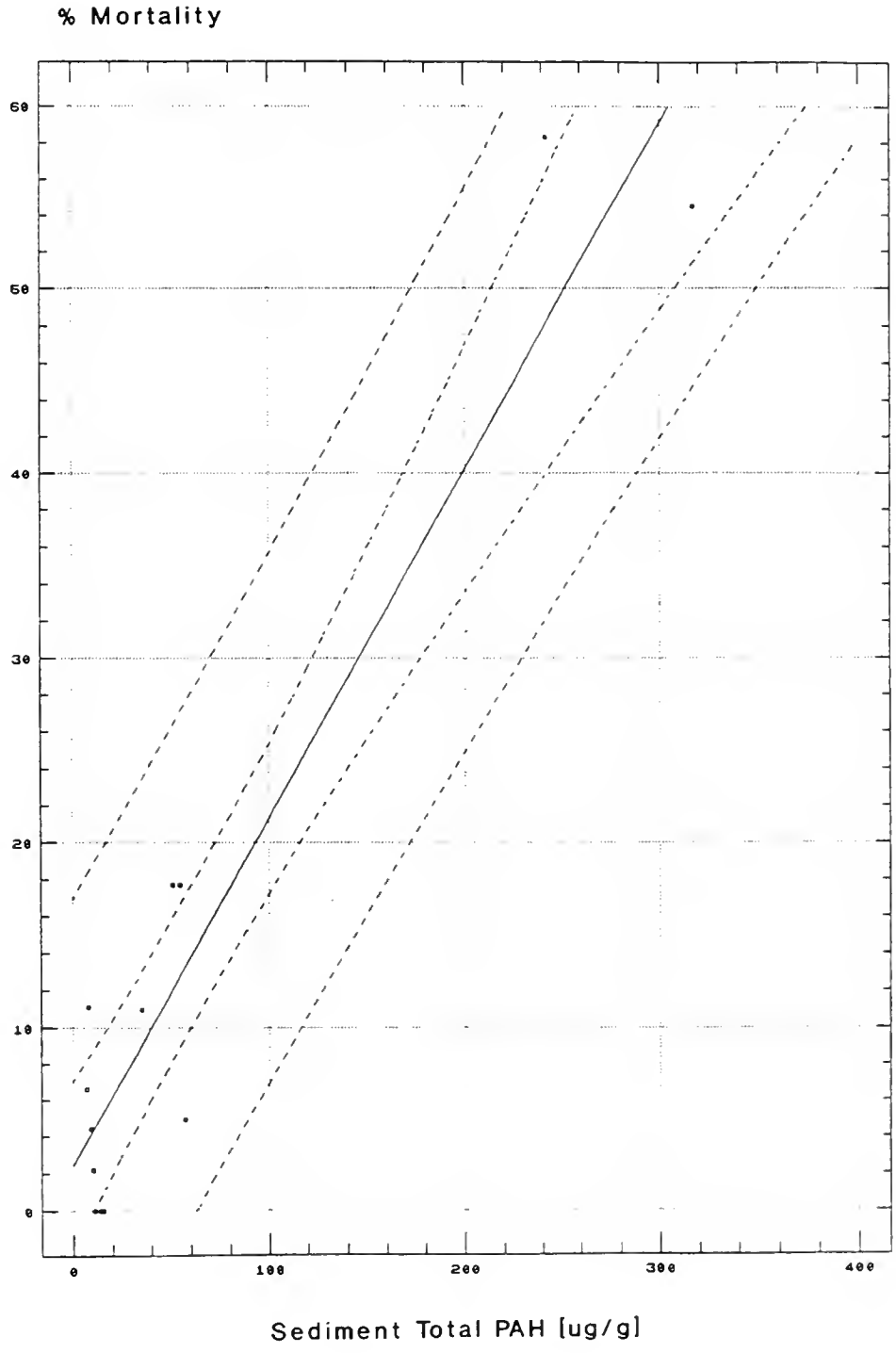

Figure 26: Sediment Total PAH and Fathead Minnow Mortality, Phase I

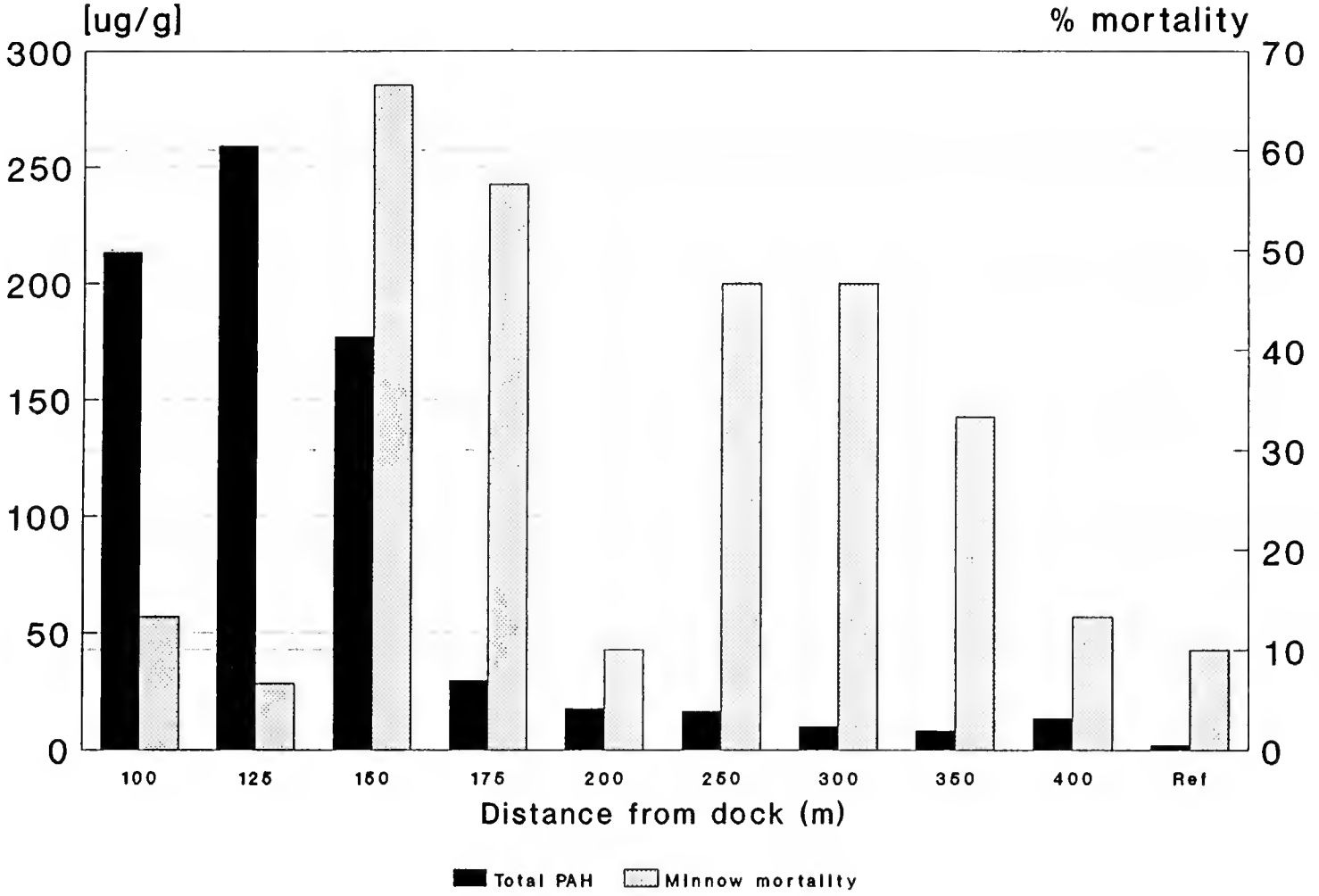

Figure 27: Fathead Minnow Tissue Residues

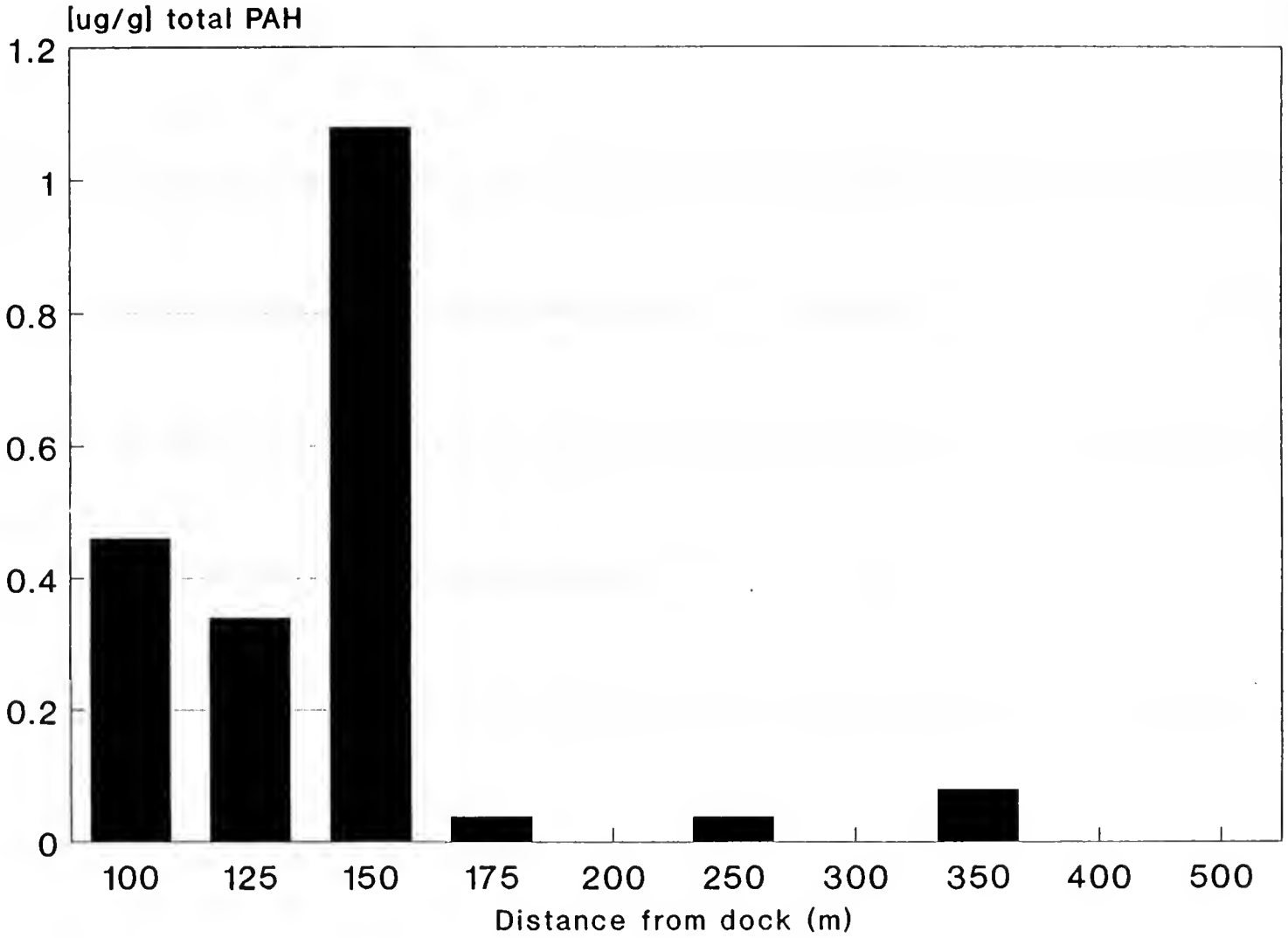

Figure 28: Total PAH Concentrations in Sediment. July and September 1995
(Concentrations are in ppm, surficial sediment)

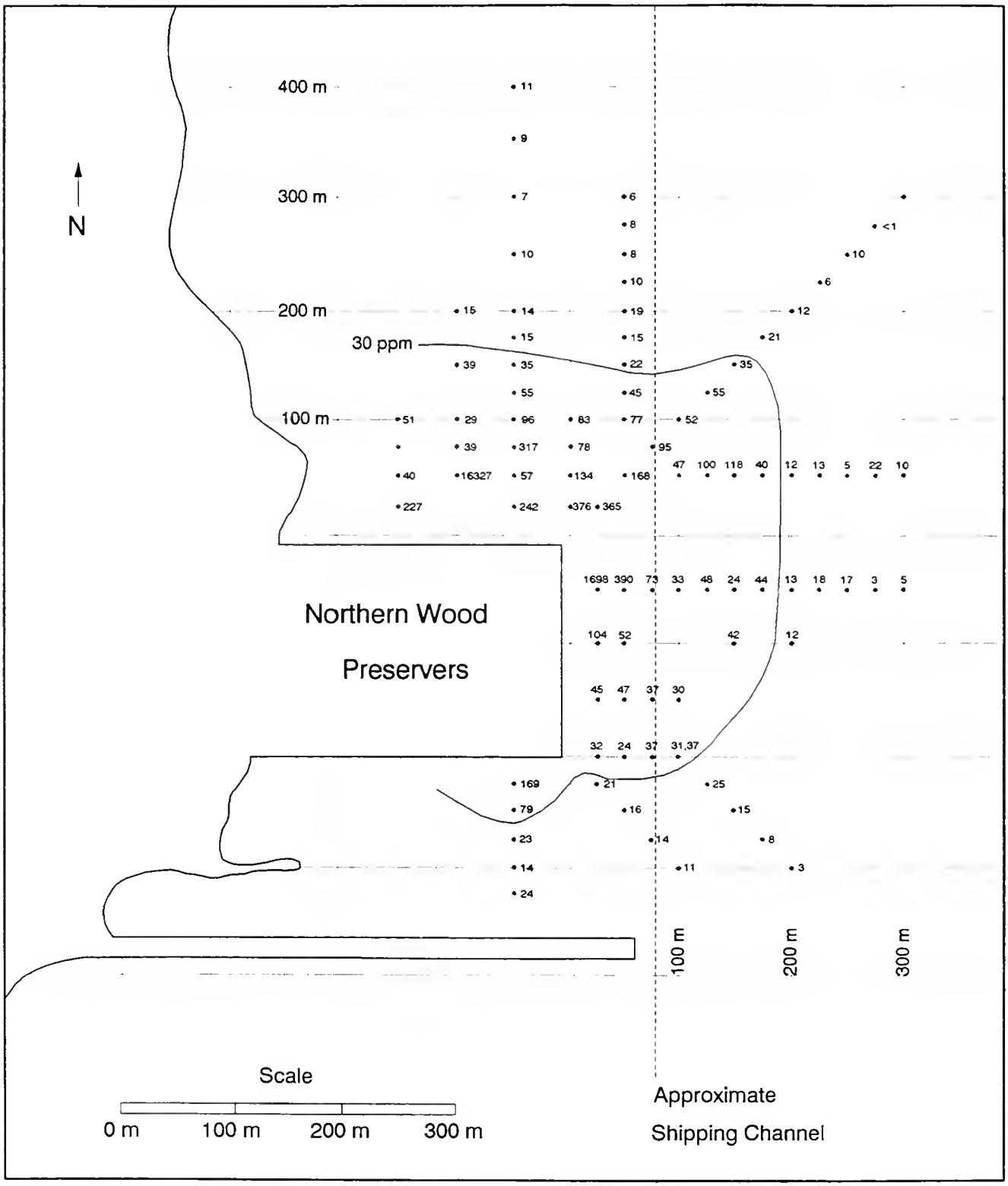

Figure 29: Delineation of Cleanup Zones based on Total PAH Concentration in Surficial Sediment

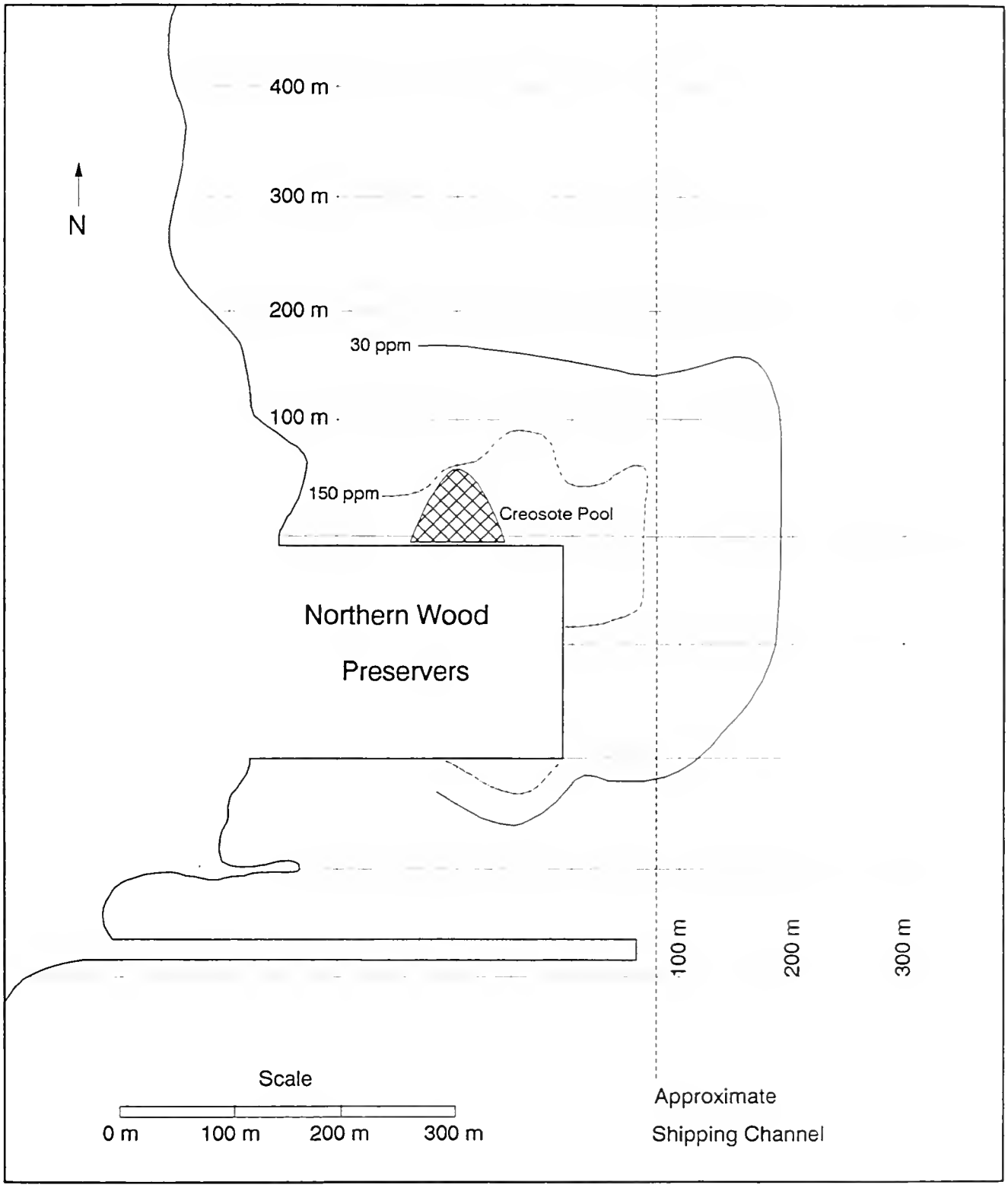
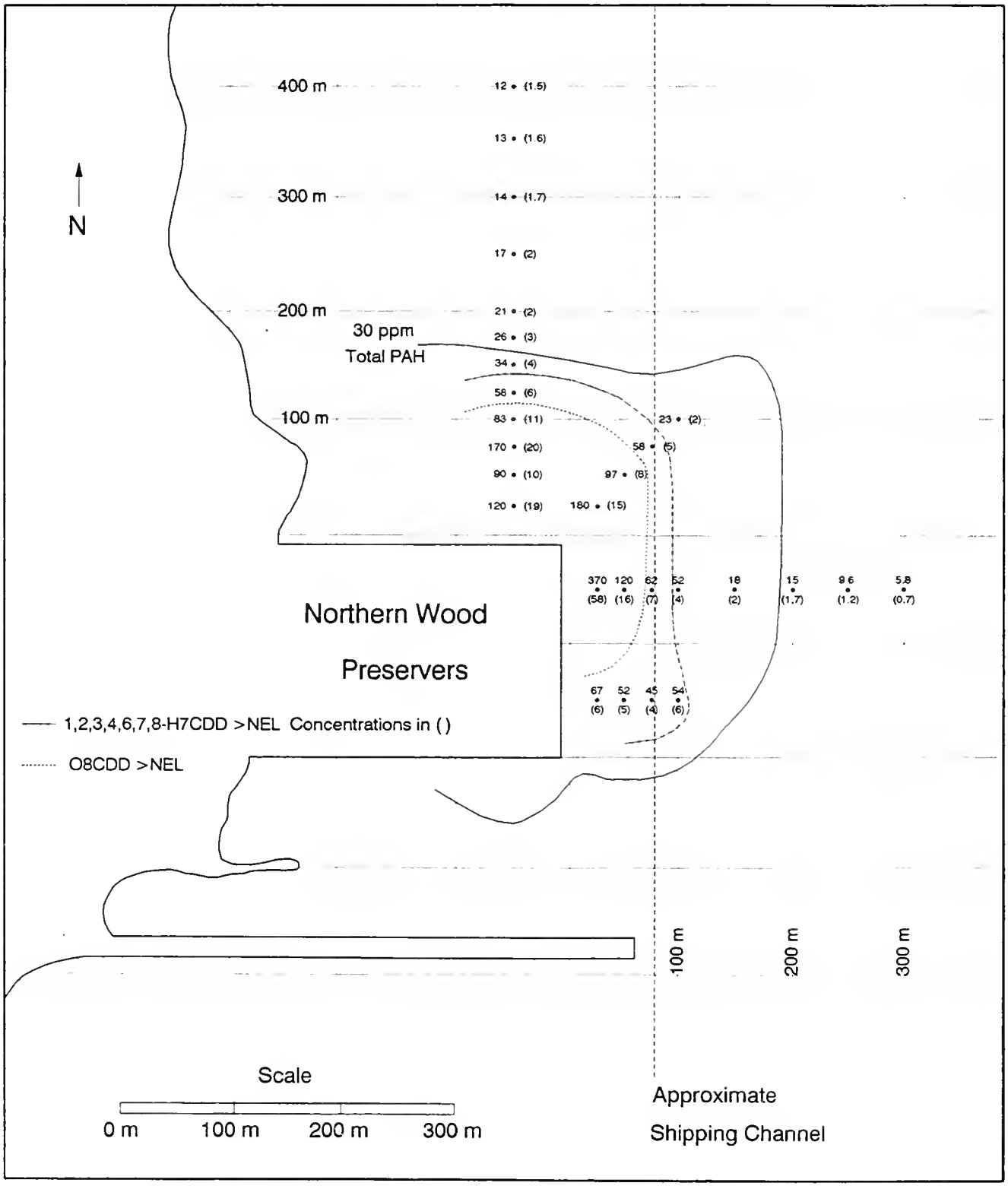
Figure 30: Concentrations of Selected Dioxins in Surficial Sediment. July and September 1995 (Concentrations are in ppb)